ONTENTS

No. 1

THE CRITICAL FREQUENCY LIMEN FOR VISUAL FLICKER IN CHILDREN BETWEEN THE AGES OF 6 AND 18 3

By Vernon L. Miller

SOME FACTORS DETERMINING HANDEDNESS IN THE WHITE RAT 55

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No. 2

MOTIVATION AND BEHAVIOR 121

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THE CRITICAL FREQUENCY LIMEN FOR VISUAL FLICKER IN CHILDREN BETWEEN THE AGES OF 6 AND 18*

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Acknowledgments 5

I. Introduction 7

II. Apparatus 13

III. Experiment I: The critical frequency limen for visual flicker in children 21

IV. Experiment II: The influence of loss of sleep on the critical frequency limen for visual flicker in children 41

References 53

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This monograph is based on a dissertation entitled *The Critical Frequency Limen for Visual Flicker in Children* presented in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Graduate School of the Ohio State University. The writer wishes to acknowledge his gratitude to Professor Samuel Renshaw for suggesting the problem and making many helpful suggestions throughout the course of experimentation, and to Dr. Matthew Luckiesh of the Nela Park research laboratory of the General Electric Co. for advice in designing the apparatus. Through the generosity of Dr. C. H. Calhoon, Executive Psychologist and director of the Bureau of Juvenile Research at Columbus, Ohio, the children under examination in that institution were made available as subjects.

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I. INTRODUCTION

In 1878 Soltmann performed a series of experiments in which the muscles and motor nerves of newborn and adult mammals (dogs and rabbits) were stimulated by artificial electrical means, and found a characteristic difference between the reactions of young and mature animals. Among other things it was found that the muscles of the young were more highly susceptible to tetany. When a muscle is stimulated repeatedly by intensive electric shocks, unless the frequency of stimulation be too great, a contraction corresponds to each stimulation. Beyond the critical frequency continuous contraction results. This limit lies between 70 and 80 stimulations per second for the adult animal, but in the newborn is as low as 16 to 18.

Koffka (1924), calling attention to the above work, pointed out *the analogy between fusion in vision and tetany produced by intermittent stimulation*, holding that the conditions which determine the critical frequency in both cases are very much the same.

> Therefore, the inference may be drawn that the critical frequency for fusion—that is, the lowest frequency that will just produce it, which in the case of adults is about 50 periods per second—might be very much lower for infants. This fact *may be difficult to prove; but at all events there is nothing* known to contradict such an inference.

The experiment here reported is an investigation of the validity of Koffka's inference that there are age differences in the critical frequency limen for visual flicker in children.

Since it is impossible to determine the critical frequency limen for infants, and the problem cannot be attacked with any degree of validity until the child has reached a sufficient age to understand the nature of flicker and fusion when they are demonstrated to him, our investigation was necessarily based upon a study of children of six years of age or older.

Meili and Tobler (1931), in a study of stroboscopic movement, discovered that optimal movement and simultaneity appear much more easily in the child than in the adult. Suspecting that this difference might be related to a corresponding difference in the persistence of vision in the child and the adult they undertook a minor investigation of this latter problem by using a disc of equal black and white sectors with a diaphragm to delimit the test spot. The experiment was performed on eight children between five and six years of age and on five adults of unspecified age. While the experimenters made no effort to control pupillary variations or the brightness of the surrounding field and do not report the state of dark adaptation employed, the results are nevertheless of interest. The experiment showed that the persistence of vision, or of the physiological processes corresponding to it, is not significantly greater for the child than for the adult.

Woodworth (1938) has called attention to the distinctness of the retinal-after-lag and the phi phenomenon. The first effect cannot serve as an explanatory principle for the second.

Hartman (1934), being unaware of our own investigation reported in summary form by Renshaw, Miller, and Marquis (1933) in relation to a study of the influence of motion pictures on children, starting with Koffka's suggestion repeated our experiment, but without the many careful controls which we employed. Thirty young children and 30 adults were used in this study. The experimenter used as the test objects a disc with equal proportions of white and black and a second disc with equal parts of yellow and blue. A 100-watt ceiling light was used for illumination and observations were made at a distance of four feet from the rotating disc. While only persons with 20-20 vision who had passed a color-blindness test were used, no attempt was made to control pupillary variations and the method used to control fixation left much to be desired. The author reports that precautions against taking advantage of peripheral vision were made "by adjusting the observer's chair so that his eyes were in a straight line with the mixer." The subjects were asked to watch the flicker at the edge of the disc and look directly at that area. There is, of course, no way of knowing how adequately these instructions were carried out. The experiments appear to have been performed under normal daylight adaptation. Confidence of the children was gained by a timely distribution of candy and by encouraging them to inspect laboratory curios. Two subjects were eliminated for evident suggestibility and unreliability. The critical speeds of rotation were determined with an engineering tachometer.

The records were obtained by means of three ascending and three descending series and "if any one of the readings deviated markedly from the trend established by the remaining values, it was thrown out and an extra record was made." In all instances the black-white determinations preceded the blue-yellow determinations, making the comparison with our own results somewhat more significant than if the reverse order had been employed.

It was found that the flicker frequency limens were definitely lower for the adults than for the children who averaged eight years of age, although the difference was not very great, so that Hartman concludes that "the measured behavior of children of primary school age and young adults reveals substantially the same performance, with respect to the rate of revolution at which flicker ceases to be detected" and that "evidently the fundamental mechanisms involved in this type of visual discrimination achieve maturity early in life." It will be noted that this conclusion is in essential agreement with the results of Meili and Tobler.

More recently Simonson, Enzer, and Blankstein (1941), noting that Cobb (1934), Riddell (1936), and Ferree and Rand (1934) had surmised that a decrease in the fusion frequency occurs with increasing age, have investigated this problem throughout the age range from 10 to 80. Since only four of their 47 subjects were within the age range of 10 to 19 and most of our subjects fell within this age range and some were younger, their study may be regarded as a continuation of our own study into the higher age brackets, so that the two studies fittingly supplement one another. Simon, Enzer, and Blankstein used apparatus rather similar to our own. A 25-watt bulb illuminated a 100 sq. mm. test-patch of opal glass subtending a visual angle of ½°. The field surrounding the test-patch had a vertical illumination of 2 foot-candles. Three sectored discs were used each having four equal openings. The light phases of the three discs covered 64, 27, and 17.5 per cent of the total flicker cycles respectively. Judgments were made after exposure periods of 1.5 seconds which Riddell had considered to be the physiological optimum. Apparently no artificial pupils were used. The relative results for the different age groups were the same for all three discs, although the absolute fusion frequencies increased with a decrease in the duration of the light phase. This finding indicates that the light phase covering 50 per cent of the flicker cycle which was used in our study provided an adequate criterion for studying age differences. The sexes were equally represented in the study of these investigators and the results of the two sex groups are not presented separately, so that evidently no significant sex difference was found. The results were found to be highly reproduceable from day to day and the discrimination of flicker was not found to improve with training. In exceptional cases individual variations of 11.5 flicker cycles were noted. The chief conclusion of the study was that there is a general definite decrease of fusion frequency with age as demonstrated by the average and maximum fusion frequency values for the different age groups, although the minimum values showed no significant change through the age range studied. This statement, however, needs to be qualified by the observation that the difference in the average fusion frequencies between the 10-19 and the 20-29-year age groups, which yielded averages of 45.9 and 46.2 flicker cycles respectively, is so slight as to be negligible. This fact should be borne in mind when comparing the results of this study with the results of the present investigation. In fact, the minimum, maximum, and average values of these two age groups were equal within the experimental error.

The phenomenon of flicker in vision may be described simply. If a cardboard disc composed of a number of equal alternate black and white sectors be rotated at a slow speed, the black sectors, may, of course, be seen to rotate about the center like the spokes of a moving wheel. As the speed of rotation is increased, a point is reached at which the direction of rotation of the black sectors cannot be discriminated, although rapid variations in the apparent brightness of the disc are easily discriminated. As the speed is further increased, a point is reached at which flicker (the variations in brightness) can no longer be discriminated, but the disc appears to be a uniform gray. The lowest speed at which fusion occurs is the critical frequency limen or "fusion frequency."

The same effect may be produced by interrupting a steady source of illumination with an episcotister, a rotating disc in which the alternate sectors have been cut out. An advantage of this latter method is that it permits complete darkness for the dark phase of the flicker cycle and somewhat better control over the light phase of the flicker cycle.

The experiments described in this monograph were performed in order to secure more definite information on questions such as the following:

1. Is the critical frequency limen for visual flicker for children a function of chronological age or maturity?
2. Is there a sex difference in the critical frequency limen?
3. Are there diurnal variations in the critical frequency limen?
4. Does practice alter the critical frequency limen?
5. What is a suitable method for making determinations of the critical frequency limen for visual flicker for children?
6. *Is reflected or transmitted light more suitable for making* determinations of the critical frequency limen?
7. Does loss of sleep affect the critical frequency limen?

The results also bear on other questions of a more theoretical nature, although they offer no direct answer to these questions. Persistence of vision, of which the critical frequency limen of flicker is a measure, may be found to be related to perseveration in children. If so, the critical frequency measure would serve as a convenient index of differences in perseveration. A practical consideration is the bearing of the results on the question as to whether the present rate of interrupting the light of the motion picture projector is suitable for children and adults of all ages.

II. APPARATUS

In the absence of a dark room in the institution where the study was conducted, the apparatus was designed to provide its own dark room. The mechanism is compact, easily portable, and has been found suitable for work with children. While the plan of the apparatus is relatively simple, provision has been made for controlling as many of the experimental variables as possible. The present design was adopted after consultation with Dr. M. Luckiesh, who has worked on the influence of the wave-form on the critical frequency of flicker.

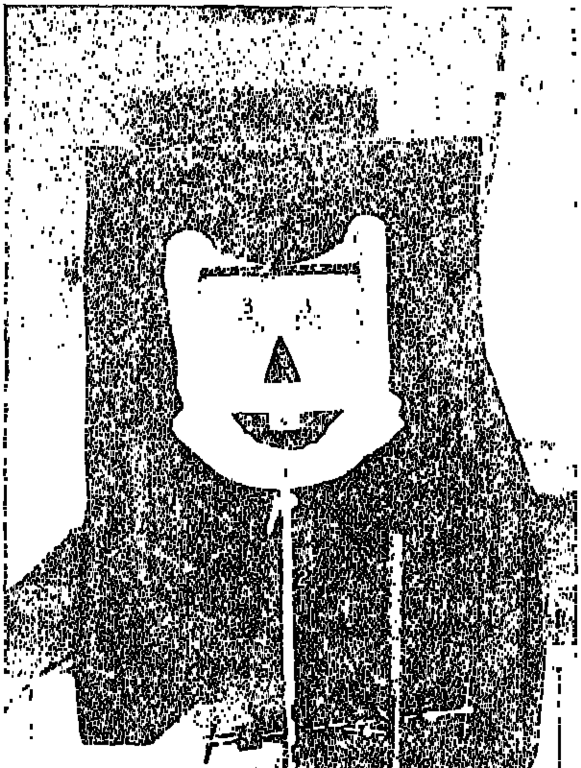

FIGURE 1
Head Rest

The parts are mounted on a wooden base 13 in. wide and 55⅛ in. long. The head rest (1, Figure 1) is mounted on a separate standard by means of an adjustable clamp, thus preventing the possibility of any vibration being transmitted to the head. The motor (1, Figure 1) is mounted on a pad of sponge rubber and runs practically without vibration, but we thought it best to provide against any possibility of interference from this source. On the vertical post (2, Figure 1) is mounted a mask of galvanized iron which supports two strips of sheet brass 1¼ in. x 4¾ in. The mask provides a triangular opening for the nose and a rectangular opening for each eye. The strips of sheet brass (3, Figure 1) have holes 2 mm. in diameter in them, which serve as artificial pupils. By sliding these strips horizontally in front of the rectangular openings in the mask the pupils may be adjusted for the interocular distance of the subject.

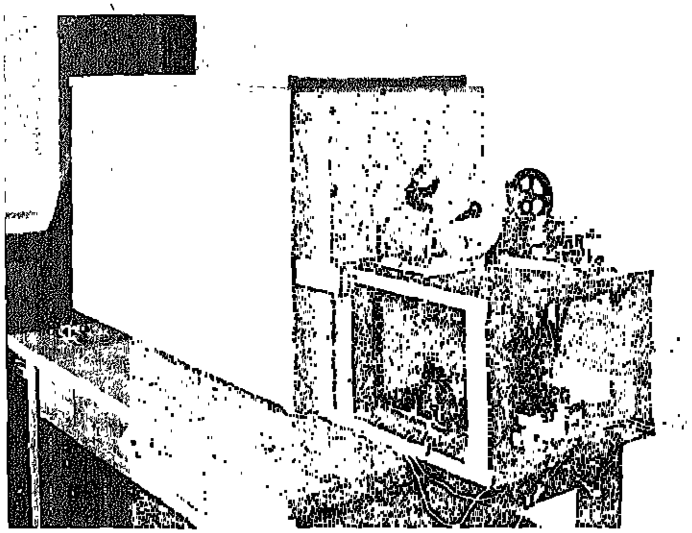

FIGURE 2
END VIEW

A 21 c.p. automobile headlight is mounted in a metal housing (1, Figure 3). The interior, as well as the exterior, of this lamp house is black. A hole ¾ in. in diameter in the metal slide (2, Figure 3),

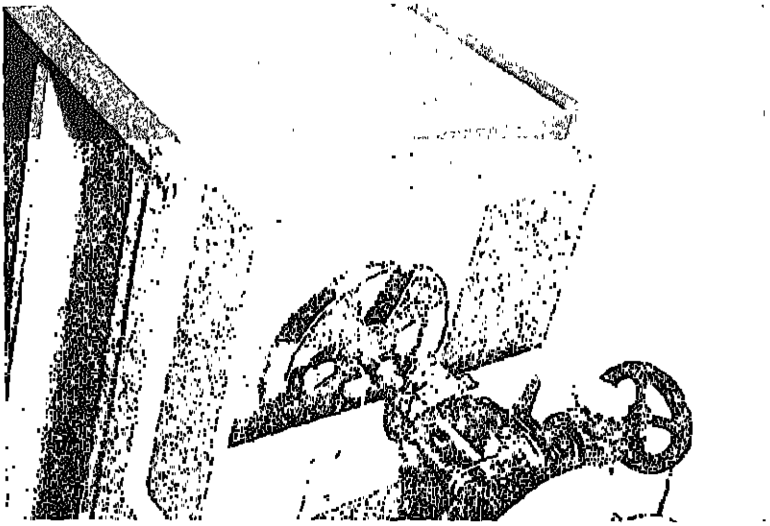

FIGURE 3
Speed Reducing Mechanism

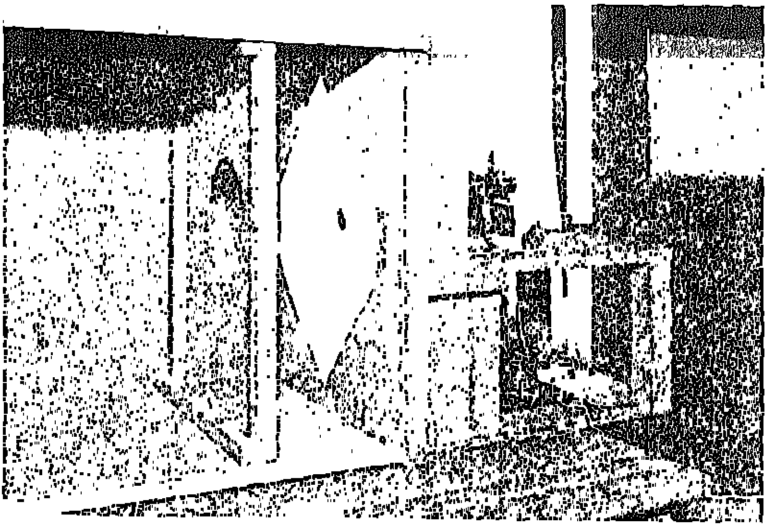

FIGURE 4
Interior

covering the front of the lamp house permits a beam of light to illuminate a piece of opal glass (3, Figure 3) mounted on a post 2¼ in. in front of the light filament.

A rotating sector disc (4, Figure 3) driven by an adjustable speed reducer (5, Figure 3) intercepts this beam of light at a point midway between the filament and the opal glass. The sector disc is 6½ in. in diameter with the alternate 45° sectors open; therefore when the disc is in rotation, there are four flicker cycles per revolution, each cycle being composed of an equal light and dark interval. The disc is painted a flat black. When a closed sector is intercepting the beam of light from the lamp house, the dark-adapted eye cannot detect any illumination on the opal glass.

A white cardboard (1, Figure 4) serving as a screen, is 1¼ in. in front of the opal glass and one meter from the artificial pupils. A circular opening 1¼ in. in diameter with its center 10⅜ in. above the base board in this screen determines the area of the flicker patch, the subject viewing the opal glass through this opening.

Immediately in front of this white screen is a rectangular frame (2, Figure 4) in each angle of which is mounted a 6 c.p. automobile light. The inner surface of this frame is lined with white cardboard, and triangular pieces of white cardboard are tacked over the corners on the front of the frame, so that by reflecting surfaces the four lights give a fairly uniform illumination over the surface of the screen. When the screen is viewed through the artificial pupils, its illumination appears quite uniform.

A second screen (3, Figure 4) with a circular opening 6 in. in diameter and concentric with the circular opening in the first screen, is 6½ in. in front of the first. This opening in the second screen serves to limit sharply the area of the white screen when it is viewed through the artificial pupils, which, when adjusted properly for interocular distance, are in register with this large opening, the pupils being always at the level of the center of the small opening in the white screen.

Panels of Masonite attached to a frame near the front of the apparatus and to the frame carrying the white screen make a housing which provides a dark tunnel between the subject and the screen. Attached to the front frame is a hood of black satin. This cloth is draped over the subject's head and shoulders, completely excluding all light from without. Everything within the tunnel is painted a flat black with the exception of the white screen.

Behind the white screen a Masonite housing encloses a second dark chamber in which are located the lamp house, sector disc, and opal glass referred to above.

The sector disc is driven by a reducing friction disc drive manufactured by the Central Scientific Company (catalog No. F1025A). This mechanism is mounted on the top platform. It in turn is driven by a synchronous motor by means of a ⅛-inch round leather belting. A horizontal scale (2, Figure 2) has been provided with one scale unit for each revolution of the control screw. A vertical circular scale (3, Figure 2) permits readings to hundredths of a revolution or of each horizontal scale unit.

Repeated calibration of the scale has shown the scale readings to be consistent within an error of plus or minus one-half of one per cent, so long as the rubber driving disc shows no considerable wear.[1] We have found discs made of the composition rubber used for soles of shoes to be more durable and to give constant readings for a much longer period. The accuracy of the scale readings was checked by frequent calibration readings throughout the experiment. This mechanism provided a way of varying the speed of the disc with the use of a synchronous motor whose speed should be independent of variations in the load on the *AC* line.

Mounted on the upper platform was a voltmeter (4, Figure 2) permitting a constant check on the drop in the *DC* circuit supplying the automobile lights. This circuit was supplied by two 6-volt automobile storage batteries in parallel.

The switch (5, Figure 2) controlling the motor, the knife switches (6, Figure 2) controlling the 21 c.p. light, and (7, Figure 2) controlling the four 6 c.p. lights, and a telegraph sounder are mounted on the base board below the platform. This sounder is connected to a telegraph signal key mounted within reach of the subject on the table upon which the whole apparatus rests.

An adjustable piano stool is provided for the subject.

This apparatus provides for the control of the following factors.

---

[1] Small variations in the frequency of the alternating current produced somewhat greater variations in the scale readings from day to day. Table 1 shows the magnitude of these variations throughout the experiment.

The constancy of the intensities of the light illuminating the flicker area (hereafter referred to as the "test patch") and the lights illuminating the screen surrounding the test patch (the screen hereafter being referred to as "the field") was assured by supplying the current from the two storage batteries and checking the voltage drop when the lights were on. The batteries were charged regularly and their condition checked by hydrometer readings.

The average illumination of the field, as determined with the Macbeth illuminometer, was 5.44 foot-candles, with a mean deviation for 20 readings of 0.0286, which is 5 per cent of the mean.

As mentioned above, a 21 c.p. automobile lamp illuminated the test patch.

No provision was made for varying either the brightness of the test patch or that of the field, these conditions being kept constant throughout the experiment. Preliminary experimentation had shown that adaptation effects were minimized by maintaining a constant field brightness throughout a series of readings, and that the eyes seemed to tire less readily when the field illumination was somewhat below that of the test patch.

Frequency of the cycles was controlled by the reducing friction disc drive, and constancy at any frequency was assured by use of the synchronous motor.

The wave-form was determined by the nature of the sector disc. Each cycle was composed of an equal light and dark interval, the dark interval being as nearly of zero brightness as it was possible to make it. The transition from one interval to the other was not abrupt but gradual owing to the time required for a closed sector to completely intercept the beam from the lamp house.

As pointed out above, it has been demonstrated that for intensities of this order the luminosity of the light, without respect to its wave-length, determines the critical frequency. Therefore no attempt was made to control the wave-length of the light, which, however, was constant throughout the experiments.

The distance of the eyes from the test patch was controlled by the position of the artificial pupils, while the head rest prevented head movements. The artificial pupils not only served their original purpose of overcoming variations in the intensity of the stimulation of the retina which would be consequent upon changes in dilation of the natural pupils, but also prevented eye-movements from escaping the subject's notice, since any eye-movement would throw the eye out of line with the adjusted pupil. Eye movements as a source of error have been noted by other investigators.

The use of both eyes assures equal adaptation of both, thus preventing any variations that may arise from the state of adaptation of the unused eye upon monocular observations, as noted by Allen (1923). Owing to their different positions with respect to the test patch, which is viewed through the circular opening in the white screen, the phases of the flicker cycles are not absolutely synchronous for both eyes. However, Sherrington (1904) has shown that when the phases are completely opposite for the two eyes, only a relatively small reduction in the critical frequency of flicker results.

Preliminary experimentation showed that if an attempt was made to dark-adapt the subject's eyes, the child would grow restless and irritable before the flicker determinations had been started. It was found that if the field was kept illuminated throughout a series of readings, the successive determinations revealed no trend which might be attributed to adaptation. Since readings for the same subject were in good agreement from day to day by using this method, no attempt was made to dark-adapt the eyes.

III. EXPERIMENT I: THE CRITICAL FREQUENCY LIMEN FOR VISUAL FLICKER IN CHILDREN

A. METHOD

Before any readings were attempted, a preliminary demonstration was performed to teach the subject to discriminate flicker and fusion. This demonstration was made with a color mixing motor, the speed of which was controlled by a rheostat. A disc composed of four 45° white sectors separated by equal black sectors was mounted on the shaft of the color mixer. The subject was told to watch the disc. As it was rotated at a slow speed, the experimenter pointed out to the child the fact that "the black parts turn around like the spokes of a wheel." The speed was gradually increased until the flicker became slight. At this point the experimenter pointed out that "it would be hard to tell which direction the black parts are going." The speed was then increased beyond the fusion point and the experimenter told the child, "Now the circle looks just like a piece of plain gray paper, doesn't it?" The series was then repeated and it was explained that at the point where the direction of rotation could not be discriminated the disc was "flickering," and at the point of fusion "the flicker goes away." The series was then repeated several times, each time the child being required to tell when the flicker disappeared.

After the experimenter was convinced that the child understood what was meant by "flicker" and was able to discriminate the point at which it disappeared, he was seated upon the piano stool, after adjusting it to the proper height. The head rest and artificial pupils were then adjusted until the subject could see "the whole circle" (the field) with both eyes when the field was illuminated.

The cloth was then draped over the subject's head and he was instructed not to move his head until told to do so. The light illuminating the test patch was now turned on and the motor driving the sector disc was started with the speed reducer set at a slow speed so as to give a pronounced flicker. The subject was next told that the flicker in "the small circle" (the test patch) looked just like the flicker in the demonstration disc. Gradually speeding up the sector disc, the procedure in the preliminary demonstration was repeated, this time the subject observing the disappearance of flicker in "the small circle."

The forefinger of the subject's right hand was then placed upon the telegraph key, and he was instructed to "press the key when the flicker disappears." The speed of the sector disc was then gradually increased until the subject pressed the key signalling the experimenter by the click of the telegraph sounder. At this signal the experimenter noted the scale reading. The procedure was then repeated until the experimenter became convinced that the subject had mastered the method.

In taking the readings the field and test patch were illuminated and the sector disc was rotated at a speed well below the fusion point. The speed was increased very gradually by turning the control screw at the rate of about 10 per cent of a revolution per second until the subject signalled the disappearance of flicker. Immediately upon receiving this signal the experimenter stopped turning the control screw, allowing the sector disc to continue rotating at the speed at which the signal had been given.

The experimenter then said, *"Tell me if the flicker comes back."* Preliminary work had shown that the flicker sometimes does come back at the speed at which its disappearance has been reported. Thirty seconds were allowed for the reappearance of flicker. If the subject did not report its reappearance, the 21 c.p. light illuminating the test patch was turned off and a 30-second rest interval was allowed before beginning the next reading, the field lights remaining on and the subject being instructed to fixate the dark test patch during the rest interval.

If the flicker did reappear, the experimenter resumed the procedure of increasing the speed of the sector disc at the same rate as before, again instructing the subject to press the key when the flicker disappeared. When the second disappearance was signalled, the experimenter stopped turning the control screw, and 10 seconds were allowed for a second reappearance of flicker. If it reappeared, the procedure was repeated, a 10-second interval being permitted for the reappearance of flicker after each signal, until a speed was reached at which the reappearance of flicker was not reported within the 10-second interval. This last reading was then recorded as the critical frequency.

After some practice in discriminating the disappearance of flicker, the exact speed of disappearance can be discriminated correctly, and flicker does not reappear during the 30-second interval following the first signal for most subjects. However, for a few, several increases are required to achieve the critical point, even after practice. We feel that this precaution greatly increased the validity of the readings.

The procedure, then, was to allow a 30-second rest interval between readings, the subject fixating the dark test patch surrounded by the bright field during this interval. As noted above, the successive readings under these conditions revealed no trend which could be attributed to adaptation. Only five readings were taken at a sitting, since a longer series would have imposed unnecessary eyestrain. The children also showed a tendency to get restless after this number of readings.

The method described was adopted after trying out various other procedures in a preliminary experiment. Stepwise changes in the speed of the sector disc were rejected after trial because they do not permit a determination of the exact point of fusion. Lythgoe and Tansley (1929) used the method of introducing dark intervals during a single reading, believing this method to permit a more precise determination of the critical frequency. This was possible in their experiment, in which the subjects, who were trained in research, controlled the speed of the sector disc themselves. In our experiment such a procedure would have been impractical, and the younger children would have confused these dark intervals with the phenomenon of flicker. The same investigators also used as their criterion of the critical frequency the point at which the flicker was just on the verge of disappearing, on the grounds that the point of disappearance is usually overestimated. This criterion is obviously unsuitable for work with children.

The method adopted had the advantage of making only the simplest requirement of the subject, i.e., that he press the key when the flicker disappeared. The control of the change in speed by the experimenter obviates the possibility of the subject's discrimination being based to any extent upon kinaesthetic or cutaneous cues such as might be the case if the subject were to operate a control screw himself.

The possibility of the subject's discrimination being based upon the time elapsing between the beginning of a reading and the point at which the critical frequency was reached was ruled out by the method of starting the separate readings at different speeds, always taking care, however, to have the starting speed well below the fusion point. The rather high consistency of most of the readings may be taken as sufficient evidence of the adequacy of the method. Each subject was tested on at least three different days, five readings being taken at a sitting, and the conditions remaining constant.

It was also discovered in the preliminary tests that measures based on the point of disappearance of flicker, using the method described above, gave more consistent readings than measures based on the first appearance of flicker in a fusion to flicker series.

B. Results and Conclusions

1. *Subjects*

The 44 boys and 34 girls used as subjects in this experiment were temporary inmates of the Bureau of Juvenile Research, an institution under the administration of the Department of Public Welfare of the State of Ohio, and located at Columbus, Ohio. The experiment was performed in the institution. These children all have *IQ*'s of 80 or better and do not differ in any essential respects for the purposes of our experiment from any other group of children of like size which might be regarded as constituting a fair sampling of the general population. With but very few exceptions all cases classified as "psychopathic" were eliminated in our selection of subjects. While individual opthalmological examinations would have been desirable, our resources did not permit them. The visual tests given by the institution served as guides in our preliminary selection of subjects, while the subject's performance during the first sitting proved to be an adequate supplementary test of his suitability. No cases having indices exceeding 20-40 in the Snellen test were considered. It is to be borne in mind that the discrimination of brightness differences, which is the basis of the discrimination of flicker, is the most primitive response the eye can make to light; this type of sensitivity is not dependent upon perfection in the auxiliary structures of the eye. In any case, the condition of the eyes of the subjects in our experiment was no better or worse than would be encountered in any fair sampling of the child population.

2. *Calibration of Scale*

Throughout the experiment calibration readings were taken of the scale readings 1.00, 2.00, and 3.00, most of the readings falling within the range of 1.00 to 3.00. The speed of rotation of the shaft driving the sectored disc was determined by means of the revolution counter attached to the reducing mechanism. The *r.p.s.* for three successive 30-second intervals for each scale reading were taken from time to time during the experiment. It was found that the calibration readings taken successively agreed with one another within limits of plus or minus 5.50 per cent. However, readings taken on successive days showed a greater variation. This variation can be attributed partly to minor cyclic variations in the alternating current, but to some extent the variation is instrumental, diminishing as the speed of the shaft increases. Table 1 gives the means of the averages of successive 30-second calibration readings taken each day throughout the experiment. It is to be noted that the sigma of the variations on successive days, which is 9.27 revolutions for the 30-second interval for the scale reading 1.00, is reduced to 5.72 for the scale reading 3.00, the relative reduction being much greater, as represented by the sigmas expressed as percentages of the means.

TABLE 1

CALIBRATIONS FOR 30-SECOND INTERVALS

Scale reading	Mean for 30 secs.	Sigma for 30 secs.	Sigma per cent	Cycles per sec.
1.00	168.44	9.27	5.5	22.456
2.00	302.00	7.96	2.6	42.664
3.00	430.85	5.72	1.3	57.448

The cycles per second are computed by dividing the means by 30 to get the *r.p.s.* of the shaft, and multiplying by 4, since there are four closed sectors in the sectored disc.

Table 2 shows the equivalence of the scale readings in flicker cycles. The values from 1.00 to 3.00 are interpolated, while extrapolations have been made from 1.00 to 0.50 and from 3.00 to 5.00. The extrapolated values are somewhat less reliable, although earlier calibration showed that within the range from 3.00 to 5.00 the *r.p.s.* of the shaft follows a linear increase. The variations encountered within the range of the most significant readings, e.g., from 1.50 to 3.00, are not of sufficient magnitude to require special consideration.

TABLE 2

INTERPOLATION TABLE

Scale readings	Cycles per sec.	Scale readings	Cycles per sec.
0.50	12.36	2.80	54.49
0.55	13.37	2.85	55.23
0.60	14.38	2.90	55.97
0.65	15.39	2.95	56.71
0.70	16.40	3.00	57.45
0.75	17.41	3.05	58.19
0.80	18.42	3.10	58.93
0.85	19.43	3.15	59.67
0.90	20.44	3.20	60.40
0.95	21.45	3.25	61.14
1.00	22.46	3.30	61.88
1.05	23.47	3.35	62.62
1.10	24.48	3.40	63.36
1.15	25.49	3.45	64.10
1.20	26.50	3.50	64.84
1.25	27.51	3.55	65.58
1.30	28.52	3.60	66.32
1.35	29.53	3.65	67.06
1.40	30.54	3.70	67.80
1.45	31.55	3.75	68.54
1.50	32.56	3.80	69.28
1.55	33.57	3.85	70.01
1.60	34.58	3.90	70.75
1.65	35.59	3.95	71.49
1.70	36.60	4.00	72.23
1.75	37.61	4.05	72.97
1.80	38.62	4.10	73.71
1.85	39.63	4.15	74.45
1.90	40.64	4.20	75.19
1.95	41.65	4.25	75.93
2.00	42.66	4.30	76.67
2.05	43.40	4.35	77.41
2.10	44.14	4.40	78.15
2.15	44.88	4.45	78.88
2.20	45.62	4.50	79.62
2.25	46.36	4.55	80.36
2.30	47.10	4.60	81.10
2.35	47.84	4.65	81.84
2.40	48.58	4.70	82.58
2.45	49.32	4.75	83.32
2.50	50.06	4.80	84.06
2.55	50.80	4.85	84.80
2.60	51.53	4.90	85.50
2.65	52.27	4.95	86.28
2.70	53.01	5.00	87.01
2.75	53.75		

A tachometer would have been a highly desirable addition to the apparatus had our funds permitted it.

3. *Age and Sex Differences*

In Figure 5 ages are plotted along the *X*-axis, and scale readings are plotted along the Y-axis for both sexes. It is apparent that the correlation between age and the critical frequency limens is almost negligible. This fact is shown in another form in Table 5, which presents the means for 2-year intervals for both sexes, thus summarizing the individual readings shown in Tables 3 and 4. How-

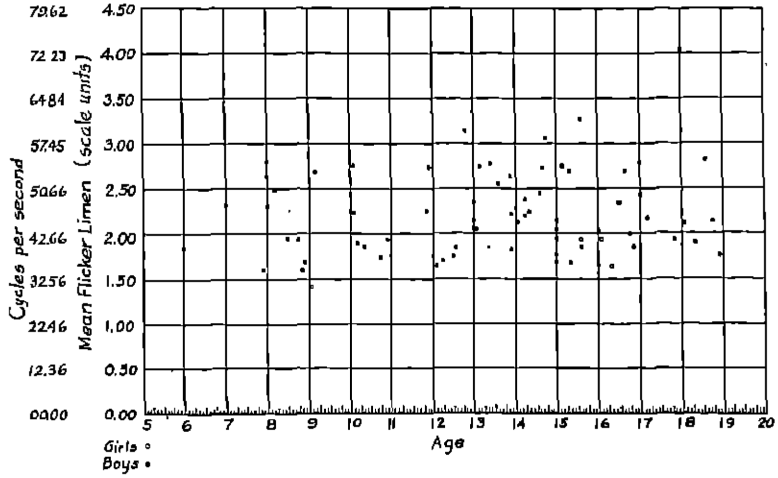

FIGURE 5

TABLE 3

NORMAL READINGS FOR BOYS

Mean flicker limen from 15 separate determinations on each subject.

Subject	Age	Mean	Sigma	Sigma %	Cycles per sec. to nearest .05
Krantz	7-11	1.610	0.0907	5.63	34.6
Croskey	8- 0	2.302	0.2700	11.73	47.1
Gailey	8- 0	2.784	0.1734	6.23	54.5
Sheylander	8- 2	2.494			
Reynolds	8- 0	2.631	0.0802	3.05	52.2
Davis	8-11	1.678	0.0670	3.99	35.6
Dowler	9- 2	2.674	0.1200	4.49	52.2
Jennings	10- 0	2.244	0.2307	10.28	46.4
Eavens	10- 1	2.238	0.2178	9.73	46.4
Steinbrook	10- 1	2.751	0.1823	6.63	53.7
Mitchell	10- 2	1.912	0.1647	8.61	40.6

TABLE 3 (*continued*)

Subject	Age	Mean	Sigma	Sigma %	Cycles per sec. to nearest .05
Ucher	10- 4	1.872	0.0501	2.67	39.6
Dew	10- 9	1.746	0.0756	4.33	37.6
Selsor	10-11	1.945	0.3810	19.59	41.6
Emery	11-11	2.742	0.3124	11.39	53.7
Manley	12- 7	1.855	0.0903	4.87	39.6
Navratil	12-10	3.140	0.3445	10.97	59.7
Hudron	13- 0	2.357	0.5580	23.67	47.8
Kuehner	13- 0	2.054	0.1501	7.31	43.4
Irvine	13- 1	2.045	0.2269	11.10	43.4
Underwood	13- 2	2.730			53.8
Allen	13- 5	2.782	0.4242	15.25	54.5
Leimbach	13- 7	2.538	0.3609	14.22	50.8
Cain	13-11	1.831	0.1526	8.33	39.6
Peterson	13-11	2.228	0.1715	7.70	46.4
Wolverton	13-11	2.630			52.3
Stuber	14- 0	2.283	0.1148	5.03	47.1
Pickering	14- 1	2.120	0.2850	13.44	44.1
Mossman	14- 7	2.467	0.1255	5.09	49.3
Friedt	14- 8	2.732	0.2213	8.10	55.7
Champlin	15- 0	1.958	0.1410	7.16	41.7
Vrutneski	15- 0	2.053	0.1260	6.14	43.4
Shanower	15- 2	2.745	0.1110	4.04	53.8
Ankrom	15- 7	3.287	0.3217	9.79	61.9
Droz	15- 7	1.862	0.1237	6.87	39.6
Keegan	16- 8	2.697	0.4906	18.19	53.0
Claffey	17- 0	2.788	0.1066	3.82	54.5
Dobson	17- 0	2.420	0.1409	5.82	48.6
Byrd	17- 2	2.156	0.1696	7.87	44.9
Clyne	18- 0	4.039	0.5189	12.85	73.0
Allen	18- 0	3.128			59.7
Long	18- 0	2.234	0.5600	25.07	46.4
Pepper	18- 1	2.108	0.1701	8.11	44.1
Weismann	18- 7	2.821	0.1057	3.75	54.5

$\Sigma = 103.217$
$N = 44$
$M = 2.401$
$\sigma = 0.4231$
σ in % $= 17.627$

ever, inspection of the means for the boys in Table 5 does suggest a slight, if irregular, age trend in the direction of increased critical frequency limen with increased age. In the age group ranging from 17 years and 7 months to 19 years and 6 months inclusive, two unusually high means (4.039 and 3.128) have an undue influence on the mean for the age group, which otherwise would show a decrease from the mean of the preceding age group. We are inclined to

TABLE 4

NORMAL READING FOR GIRLS

Mean flicker limen from 15 separate determinations on each subject

Subject	Age	Mean	Sigma	Sigma %	Cycles per sec. to nearest .05
McKinstry	6- 0	1.840	0.1074	5.95	39.6
Gorman	7- 0	2.311	0.6042	26.14	47.1
Horst	*8- 6*	*1.958*	*0.2024*	*10.33*	*41.7*
Davis	8- 9	1.942	0.1567	8.07	41.7
Green, V.	8-10	1.586	0.1337	8.43	34.6
Green, Gladys	9- 1	1.430	0.0521	3.64	31.6
Reed	11- 0	1.763	0.0953	5.41	37.6
Patterson	11-10	2.240	0.3959	17.57	46.4
Sanders	12- 0	1.756			37.6
Haenny	12- 1	1.655	0.1283	7.75	35.6
Ward	12- 3	1.716	0.1495	8.71	36.6
Sanders	12- 6	1.756	0.0473	2.71	34.6
Reno	13- 0	2.130	0.1962	9.21	44.9
Howard	14- 3	2.208	0.3610	16.35	45.6
Goodman	14- 3	2.378	0.1080	4.54	47.8
Brown, P.	14- 4	2.246	0.3085	13.74	46.3
Seward	14- 9	3.055	0.3305	10.82	58.2
Flint	15- 0	2.150	0.3413	15.87	44.9
Mann	15- 0	1.705	0.0585	3.43	36.6
Steele	15- 0	1.792	0.1817	10.14	38.6
Denty	15- 4	2.708	0.2180	8.05	53.0
Brown, D.	15- 4	1.680			34.6
Miller	15- 7	1.938	0.2187	11.28	41.7
James	16- 0	1.640	0.1093	6.66	34.6
Rayburn	16- 0	2.020			42.7
Koehn	16- 1	1.914	0.0547	2.86	40.6
Simpson	16- 4	1.643	0.0993	6.04	35.6
Aisel	16- 6	2.346	0.1875	7.99	47.8
Schlotterbeck	16- 9	1.990			42.7
Badgley	16-10	1.861	0.1080	5.80	39.6
Schenker	17-10	1.943	0.1797	9.25	41.6
van Hoose	18- 4	1.901	0.0916	4.82	40.6
Brenneison	18- 9	2.139	0.1207	5.64	44.9
Sayre	18-11	1.762	0.1311	7.44	37.6

$\Sigma = 67.102$
$M = 1.974$
$N = 34$
$\sigma = 0.3281$
σ in % $= 16.62$

believe that these unusually high scores are due to some other factor. An examination of the means for the successive age groups for the girls, Table 5, again suggests a similar trend from 7 years and 7 months to 15 years and 6 months inclusive, the means progressing from 1.729 to 2.213. However, the higher reading of 2.076 in the

TABLE 5

SEX DIFFERENCES BY AGES IN THE LIMEN FOR VISUAL FLICKER

Ages	Boys N	Boys Mean	Boys Sigma	Boys Sigma %	Girls N	Girls Mean	Girls Sigma	Girls Sigma %
5-7 to 7-6					2	2.076	.3558	17.14
7-7 to 9-6	6	2.2798	.1603	7.03	4	1.729	.1362	7.88
9-7 to 11-6	7	2.101	.1860	8.85	1	1.763	.0953	5.41
11-7 to 13-6	8	2,463	.3009	12.22	6	1.849	.1834	9.92
13-7 to 15-6	11	2.326	.1809	7.78	9	2.213	.2384	10.77
15-7 to 17-6	6	2.535	.2459	9.70	8	1.917	.1446	7.54
17-7 to 19-6	5	2.9838	.3389	11.36	4	1.936	.1308	6.76
	43	14.6886			34	13.473		
Average		2.4481				1,925		
Cycles to nearest .05		49.32				41.65		

first age group and the fall to 1.917 in the 15 years and 7 months to 17 years and 6 months group, together with the small number of cases in some groups, casts a strong doubt upon the existence of a valid trend throughout the entire age range. It is, of course, possible that the increase for the age group ranging from 13 years and 7 months to 15 years and 6 months may be definitely correlated with adolescent changes, but we do not regard our present data as in any sense offering proof of such a correlation. In this connection it is interesting to note that the corresponding peak (2.463) for the boys occurs in the preceding age group. If these peaks were definitely correlated with pubescent or adolescent changes, we should expect the peak to occur earlier for the girls than for the boys. It is also interesting to note that the variability of the readings, where sigma is expressed as a percentage of the mean, is highest at this peak (2.463 where the value is 12.22 per cent) for the boys than for any other age group. The corresponding peak (2.213) for the girls is accompanied by a higher variability (10.77 per cent) than for any other age group with the exception of the first, in which there are only two cases, thus rendering the sigma meaningless. Similar parallels could be drawn between the drops in the means from the first to the second age groups tabulated for both the boys and the girls. It is also apparent from Table 5 that the mean of the readings of all children for both sexes from 5 years and 7 months to 13 years and 6 months is lower than the corresponding mean from 13 years and 7 months to 19 years and 6 months. Yet we do not regard these data as proving a definite age trend, because of their irregularity, the small number of cases for some age groups, and the undue influence of a few unusually high readings that are probably due to some individual difference not yet isolated.

In the case of sex differences the data are more positive. Inspection of Figure 5 reveals the fact that the boys as a group have critical frequency limens considerably higher than those of the girls as a group, although, as is usual in all studies of sex differences in behavior, there is a great deal of overlapping. The mean reading for all of the boys is 2.448, while the mean reading for all of the girls is 1.925. Examination of Table 5 discloses the further interesting fact that the mean of the readings for the boys is higher than the mean of the readings for the girls for *each age group*. Another comparison of the readings shows that 20 of the boys (or 46.5 per cent) have means above 2.40, whereas only two of the girls (or 6.1 per cent) have means above this reading; or conversely, while 53.5 per cent of the boys have means below 2.40, 93.9 per cent of the girls have means below this reading. The highest mean for the girls is 3.055, while four boys have higher readings, the highest being 4.039. The lowest mean for the boys is 1.610, while two girls have lower readings, the lowest being 1.430.

In general, the readings of the boys as a group are more variable than the readings of the girls as a group, the sigma for the boys being 0.423, and for the girls 0.328. Expressed as a percentage of the mean the sigma for the boys is 17.62 per cent, and for the girls 16.62 per cent. The absolute difference in the sigmas, 0.095, represents nearly two flicker cycles.

Tables 3 and 4 disclose the fact that the variability of the 15 readings for each individual reveals no age trend.

Table 6 gives the distribution of the sigmas of Tables 3 and 4 for the boys and the girls. From this table it can be seen that 24 (60 per cent) of the boys have sigmas under 0.20, while 21 (70 per cent) of the girls have sigmas below 0.20. The magnitude of these sigmas is influenced by changes in the level of the readings from day to day, a matter to be discussed later. A relatively high sigma does not necessarily indicate great variability for the five readings taken at a

TABLE 6

DISTRIBUTION OF SIGMAS OF FLICKER LIMEN READINGS (NORMAL READINGS)

Sigmas in scale units	Boys frequency	Girls frequency
0.00-0.049	0	1
0.05-0.099	6	6
0.10-0.149	10	8
0.15-0.199	8	6
0.20-0.249	4	3
0.25-0.299	2	0
0.30-0.349	3	3
0.35-0.399	2	2
0.40-0.449	1	0
0.45-0.499	1	0
0.50-0.559	1	0
0.60-0.649	2	1
	40	30

single sitting, since the sigma is based upon the 15 readings taken in three successive sittings on different days. In Table 7 the distribution of these sigmas expressed as percentages of the means of the 15 readings is given. For 27 (67.5 per cent) of the boys and for 21 (70 per cent) of the girls the sigmas are equal to less than 10 per cent of their means, thus indicating a relatively low variability in view of the shift in level from day to day.

TABLE 7
DISTRIBUTION OF SIGMAS OF FLICKER LIMEN READINGS EXPRESSED AS PERCENTAGES OF THE MEANS

Sigma in %	Boys frequency	Girls frequency
0.00- 4.99	9	6
5.00- 9.99	18	15
10.00-14.99	8	5
15.00-19.99	3	3
30.00-24.99	1	0
25.00-29.99	1	1
	—	—
	40	30

4. *Variation Differences*

As stated before, the field was illuminated throughout a series of five readings both during the time the critical frequencies were being determined and during the rest intervals, the purpose being to minimize the process of dark adaptation which would produce an unwanted increase in the critical frequencies throughout the series. In spite of this precaution, of course, the later readings were slightly higher or lower than the earlier readings. The extent to which upward or downward trends have occurred in the successive five readings taken at a sitting we have expressed in Tables 8 and 9 in terms of "variation differences." The variation difference for a series of five readings is computed by subtracting the average of the first two readings from the average of the last two readings in the series. Thus if the trend is in the direction of higher frequencies toward the end of the series, the variation difference will be positive, and its magnitude will indicate the extent of the change and vice versa. These variation differences have been averaged both algebraically and arithmetically, the algebraic mean giving the general

TABLE 8

VARIATION DIFFERENCE IN AVERAGE CRITICAL FREQUENCY LIMENS DURING FIRST THREE DAYS OF THE EXPERIMENT—BOYS

Boys	Ages	1st Day	2nd Day	3rd Day
Krantz	7-11	—.135	—.050	—.105
Croskey	8- 0	.255	.030	—.025
Davis	8-11	—.080	—.010	—.085
Dowler	9- 2	—.310	0.15	.050
Jennings	10- 0	—.195	—.110	.055
Eavens	10- 1	.010	.065	.020
Steinbrook	10- 1	.110	—.125	.040
Mitchell	10- 2	—.110	—.220	—.290
Ucker	10- 4	—.035	—.105	—.085
Dew	10- 9	—.065	.180	—.125
Selsor	10-11	.280	.235	.020
Emery	11-11	—.010	.060	—.055
Manley	12- 7	.035	.100	—.065
Navratil	12-10	.405	.200	.380
Hudron	13- 0	.145	.225	
Kuehner	13- 0	—.180	.015	—.067
Irvine	13- 1	—.005	—.135	.270
Allen	13- 3	.045	.145	.045
Leimbach	13- 7	—.170	.615	.005
Cain	13-11	—.385	.015	.000
Peterson	13-11	.020	.030	.455
Stuber	14- 0	.220	.070	.251
Pickering	14- 1	.345	—.160	—.035
Friedt	14- 8	.625	.025	.050
Champlin	15- 0	—.035	—.075	—.090
Shanower	15- 2	.385	.030	—.005
Keegan	16- 8	.265	.435	.355
Claffey	17- 0	.085	.155	—.010
Dobson	17- 0	.035	.060	.135
Byrd	17- 2	.025	.160	.240
Clyne	18- 0	—.205	.630	.300
Allen	18- 0			
Long	18- 0	—.175	.015	.035
Pepper	18- 1	.140	.015	.065
Arithmetic Σ =		5.2525	4.515	3.813
Arithmetic M =		.167	.137	.119
Algebraic Σ =		1.335	2.535	1.729
Algebraic M =		.040	.077	.054
N =		33.000	33.000	32.000

direction of the shift for the group as a whole, and the arithmetic mean giving an expression of the average variation difference for the group as a whole without respect to the direction of the change. These means have been computed for each sitting. The algebraic means for the boys, Table 8, show that for the group as a whole the readings tended to increase slightly during the sitting on each of the

TABLE 9

VARIATION DIFFERENCES IN AVERAGE CRITICAL FREQUENCY LIMENS DURING FIRST THREE DAYS OF THE EXPERIMENT—GIRLS

Girls	Ages	1st Day	2nd Day	3rd Day
Gorman	7- 0	.235	1.395	.050
Davis	8- 9		.150	—.200
Green, V.	8-10	—.005	.080	.285
Green, G.	9- 1	—.105	—.065	.040
Reed	11- 0	—.075	.010	.020
Patterson	11-10	.095	.010	.605
Ward	12- 3	—.210	.095	.015
Sanders	12- 6	.060	.095	—.015
Howard	14- 3	.100	.185	.460
Brown	14- 4	1.005	.010	.020
Seward	14- 9	.290	.105	.230
Flint	15- 0	.080	.045	—.190
Mann	15- 0	.020	.060	.100
Steele	15- 0	—.025		—.160
Denty	15- 4	.350	.425	—.045
Miller	15- 7	.190	.025	.160
Koehn	16- 1	.010	.040	.085
Simpson	16- 4	—.085	—.105	
Aisel	16- 6	.215	—.130	—.390
Badgley	16-10	.105	—.005	.010
Schenker	17-10	.160	—.155	.055
Brenneison	18- 9	.160	.065	.095
Sayre	18-11	—.025	—.020	
Algebraic Σ =		2.545	2.315	1.230
Algebraic *M* =		.16	.105	.059
N =		22.000	22.000	21.000
Arithmetic Σ =		3.605	3.280	3.150
Arithmetic *M*=		.160	.149	.149

three days, the variation differences being 0.040, 0.077, and 0.054 for the three successive days, respectively. Table 9 indicates the same increase throughout the series of five readings on each of the three days for the girls as a group, the algebraic means of the variation differences being 0.116, 0.105, and 0.059, for the three successive sittings, respectively. Since the level of the girls' readings is lower, the relative variation difference would be slightly higher than the figures suggest. Examination of the arithmetic means of the variation differences in Table 8, 0.167, 0.137, and 0.119 for the three successive days, shows a definite downward trend in the variability of the readings, without respect to the direction of the change. This must be interpreted as an improvement in discrimination resulting from practice, if we accept the usual objective criterion of such improvement, i.e., decreased variability. Table 9 shows the same effect to a lesser degree for the girls, i.e., a drop in the arithmetic means of the variation differences, from the first to the second day, although no change takes place from the second to the third day. However, for the group as a whole, the algebraic means show a progressive decrease in the case of the girls.

5. *Effect of Practice on Successive Days*

The increase in the readings throughout a series of five readings,

TABLE 10

DAY-TO-DAY VARIATIONS FOR BOYS

Boys	Ages	1st Day	2nd Day	3rd Day	D_1	D_2	D_3
Krantz	7-11	1.702	1.546	1.582	—.156	.036	—.120
Croskey	8- 0	2.258	2.516	2.150	.258	—.366	—.108
Davis	*8-11*	*1.710*	*1.690*	*1.656*	*—.020*	*—.034*	*—.054*
Dowler	9- 2	2.732	2.682	2.608	—.050	—.074	—.124
Jennings	10- 0	2.044	2.214	2.476	.170	.262	.432
Eavens	10- 1	1.938	2.408	2.37	.470	—.038	.432
Steinbrook	10- 1	2.544	2.802	2.908	.258	.106	.364
Mitchell	10- 2	1.796	2.046	1.896	.250	—.150	.100
Ucker	10- 4	1.858	1.862	1.898	.004	.036	.040
Dew	10- 9	1.728	1.742	1.77	.014	.028	.042
Selsor	10-11	1.886	1.832	2.118	—.054	.286	.232
Emery	10-11	2.326	3.038	2.864	.712	—.174	.538
Manley	12- 7	1.770	1.874	1.922	.104	.048	.152
Navratil	12-10	2.538	2.984	3.270	.446	.286	.732
Hudron	13- 0	1.806	2.908		(1.102)		
Kuehner	13- 0	1.744	1.880	2.084	.136	.204	.340
Irvine	13- 1	1.883	1.972	2.248	.089	.276	.365
Allen	13- 3	2.780	2.658	2.910	—.122	.252	.130
Leimbach	13- 7	2.138	2.568	2.910	.430	.342	.772
Cain	13-11	1.978	1.738	1.748	—.240	.010	—.230
Peterson	13-11	2.094	2.234	2.358	.140	.124	.264
Stuber	14- 0	2.270	2.252	2.328	—.018	.076	.058
Pickering	14- 1	2.164	2.718	1.904	.554	—.814	—.260
Friedt	14- 8	2.544	2.856	2.798	.312	—.058	.254
Champlin	15- 0	1.936	1.878	2.060	—.058	.182	.124
Shanower	15- 2	2.714	2.770	2.752	.056	—.018	.038
Keegan	16- 8	2.187	2.825	3.038	.638	.213	.851
Claffey	17- 0	2.794	2.810	2.982	.016	.172	.188
Dobson	17- 0	2.234	2.508	2.518	.274	.010	.284
Byrd	17- 2	1.990	2.126	2.352	.136	.226	.362
Clyne	18- 0	3.670	3.772	4.674	.102	.902	1.004
Allen	18- 0						
Long	18- 0	2.686	1.914	2.102	—.772	.188	—.584
Pepper	18- 1	2.190	1.886	1.850	—.304	—.036	—.340
$\Sigma =$		72.632	77.509	77.104			
$M =$		2.201	2.349	2.41			
$N =$		33.000	33.000	32.000			
Algebraic $\Sigma =$					3.775	2.503	6.278
Algebraic $M =$					.118	.078	.196

as shown by the algebraic means of the variation differences, may be due to a slight adaptation effect, but any trend in the level of the readings on successive days must certainly be attributed to practice, other things being equal. Table 10 gives the means of the five readings taken at each sitting for the boys, and Table 11 gives the same data for the girls. The differences between these readings have been computed for convenience of comparison. D_1 is the algebraic difference between the mean on the second day and the mean on the first. If the mean has increased from the first day to the second, the difference will be positive; if it has gone down, the difference will be negative; and the magnitude of the difference will be a measure of the extent of the change in the level of the readings on the two successive days. The mean on the third day

TABLE 11

DAY-TO-DAY VARIATIONS FOR GIRLS

Girls	Ages	1st Day	2nd Day	3rd Day	D_1	D_2	D_3
Gorman	7- 0	2.278	3.004	2.346*	.726	—.658	.068
Davis	7- 9		1.994	1.832		—.162	
Green, V.	8-10	1.470	1.544	1.744	.074	.200	.274
Green, G.	9- 1	1.478	1.388	1.426	—.090	.038	—.052
Reed	11- 0	1.692	1.748	1.850	.056	.102	.158
Patterson	11-10	1.968	1.804	2.567	—.164	.772	.608
Ward	12- 3	1.538	1.752	1.860	.214	.108	.322
Sanders	12- 6	1.614	1.606	1.568	—.008	—.036	—.046
Howard	14- 3	1.930	2.114	2.582	.184	.468	.652
Brown, P.	14- 4	2.246	2.190	2.304	—.056	.114	.058
Seward	14- 9	2.970	2.790	3.404	—.180	.614	.434
Flint	15- 0	1.792	1.858	2.564	.066	.706	.772
Mann	15- 0	1.672	1.682	1.772	.010	.090	.100
Steele	15- 0	1.608	1.910	1.935	.302	.025	.327
Denty	15- 4	2.656	2.726	2.744	.070	.018	.088
Miller	15- 7	1.698	1.946	2.170	.248	.224	.472
Koehn	16- 1	1.876	1.960	1.908	.084	—.052	.032
Simpson	16- 4	1.684	1.602		—.082		
Aisel	16- 6	2.286	2.276	2.476	—.010	.200	.190
Badgley	16-10	1.738	1.964	1.882	.226	—.082	.144
Schenker	17-10	2.092	1.994	1.774	—.098	—.220	—.318
Brenneison	18- 9	2.098	2.124	2.198	.026	.074	.100
Sayre	18-11	1.846	1.678		—.168		
$\Sigma =$		42.230	45.654	44.915			
$M =$		1.920	1.985	2.139			
$N =$		22.000	23.000	21.000			
Algebraic $\Sigma =$					1.430	2.543	4.383
Algebraic $M =$					.358	.121	.313

*Fourth day 1.618.

minus the mean on the second day gives D_2, while D_3 is the mean on the first day subtracted from the mean on the third day. Examination of the D_1 differences in Table 10 reveals that while 10 of the boys show decreases from the first to the second day, the remainder (69.7 per cent) show increases, this tendency being represented by the algebraic mean of 0.118 for the group. The D_2 column shows again 10 decreases, but only in three cases do the same boys decrease both from the first to second and from the second to third day. The extent of the increase for the group from the second to the third day is represented by the algebraic mean 0.078, while the extent of increase from the first to the third day is represented by the algebraic mean 0.196 for the group. These figures indicate that the group as a whole tended to report the disappearance of flicker at a higher point on each successive day, but that the increase from the first to the second day was greater than from the second to the third; however, the magnitude of the increase from the first to the third day leaves little doubt as to the positive nature of the practice effect.

Table 11 for the girls shows much the same tendencies, except that the day-to-day variations are greater for the group as a whole than was the case with the boys. Nine girls show a decrease from the first to the second day, but the remainder of the group (59.1 per cent) show an increase. The increase for the group as a whole is represented by the algebraic mean 0.358. It is to be noted, however, that a few unusually high differences exert an undue influence on the means. The table also shows only six of the girls decreasing from the second to the third day, only two of these being girls who had shown a decrease from the first day to the second. The mean for the D_2 column is 0.121, thus standing in the same relation to the mean of the D_1 column as did the corresponding means in Table 10. So for the girls as a group, as for the boys, the increase was greater from the first to the second day than from the second day to the third. It is to be noted that only three of the girls show a decrease from the first to the third day, and that the mean of the D_3 column, 0.313, indicates a very positive increase from the first to the third day for the group, a tendency which is borne out in most of the individual readings.

The arithmetic means of the variation differences also show the practice effect, the differences decreasing from day to day except in the case of the girls, who show no decrease from the second to the third day.

If it be true that the critical frequency limen increases with practice, as these tables would indicate, and that the accuracy of the determinations is also a function of practice, as was shown above, then it is of great importance to make due allowance for these practice effects in making accurate determinations of the critical frequency limen for visual flicker. The effects of practice on the readings taken on successive days has hitherto never been taken into account.

6. *Bearing of Results upon Motion-Picture Projection*

At present, for sound accompaniment, motion pictures are projected at the rate of 24 pictures per second. The rotating shutter of the projection machine interrupts the beam of light thrown upon the screen twice for each picture, once while the picture is in position for projection and once during the transition from one picture to the next. The open sectors are somewhat larger than the closed sectors of the shutter, thus making the light interval relatively longer than the dark. The rate of intermittence, then, is 48 cycles per second. The lowest mean reading for the boys was found to be 1.610, which is equivalent to 35 flicker cycles per second; while the lowest mean reading for the girls was found to be 1.430, which is equivalent to 31 flicker cycles per second. The highest mean reading for the boys was found to be 4.039 (slightly below 73 flicker cycles per second). However, this is exceptional, all but four of the boys having readings below 2.900 (56 cycles per second). The highest mean reading for the girls is 3.055 (59 cycles per second). However, all but two of the girls have readings below 2.400 (48.5 cycles per second).

Four factors operate to bring the present rate of projection (48 cycles per second) within the critical frequency range for both adults and children: (a) The dark phase of the flicker cycle in motion-picture projection does not represent zero brightness, but room brightness; (*b*) the light phase represents a much lower brightness than the light phase of the flicker cycle in this experiment; (*c*) the range factor, the ratio of the difference between the light and dark phases to the light phase, is lower than in this experiment because of the preceding two conditions. (*d*) The light phase of the flicker cycle is longer than the dark phase. As a result the critical frequency of fusion is much lower. For this reason our results may not be taken as evidence that the present rate of motion-picture projection is too slow to give perfect fusion in children.

7. *Conclusions*

1. The results of this experiment, using 44 boys and 34 girls ranging from six to 18 years of age, do not disclose a definite trend in the direction of an increase in the critical frequency limen for visual flicker corresponding to an increase in chronological age.
2. In general, the critical frequency limen for visual flicker is higher for boys than for girls, although there is some overlapping of the two distributions.
3. Practice reduces the variability of the determinations of the critical frequency limen.
4. In general, practice raises the critical frequency limen for both sexes, the magnitude of the increase being greater from the first to the second sitting than from the second to the third.
5. The critical frequency limen for both sexes of all ages is sufficiently low so that the present rate of motion-picture projection should not result in the perception of flicker.

IV. EXPERIMENT II: THE INFLUENCE OF THE LOSS OF SLEEP ON THE CRITICAL FREQUENCY LIMEN FOR VISUAL FLICKER IN CHILDREN

A. Effect of Loss of the First Three Hours of Sleep

1. *Subjects*

The 10 boys and 11 girls participating in this experiment also served as subjects in the first experiment. Their ages are shown in Table 12. The boys ranged in age from 8 years to 18 years and 7 months, while the girls ranged in age from 6 years to 18 years and 4 months; the oldest girl in the first deprivation experiment, however, was 16 years and 9 months old. All of the subjects were, for the purposes of the experiment, normal, with the exception of the youngest boy, who was definitely psychopathic, being a case of congenital syphilis.

2. *Method*

The same apparatus was used in this experiment as in the first. Our primary interest in this second experiment was to determine the effects of loss of sleep upon the normal motility curve. The results of this experiment are reported by Renshaw, Miller, and Marquis (1933). However, the experiment provided favorable conditions for extending the study on the critical frequency limen for visual flicker. Many have speculated concerning functional changes in the nervous system resulting from fatigue. Since the retina is a part of the nervous system particularly accessible to experimental study, it seemed worthwhile to determine whether the critical frequency limen for visual flicker could be shown to have any definite relation to neural effects resulting from loss of sleep. In an attempt to answer this question the present experiment was performed.

For purposes of another study of sleep motility in which the writer was participating, the children serving as subjects in this experiment had been retiring promptly at 9 P.M. and arising promptly at 6 A.M. In the first deprivation experiment, now to be reported, we required the children to stay up until midnight. Retiring at midnight, they were required to arise at 6 A.M. as before. For five successive nights the children suffered the loss of the first three hours of their usual night's sleep. On two or more days during this period critical fre-

TABLE 12

EFFECTS OF LOSS OF THE FIRST THREE HOURS OF SLEEP ON THE FLICKER LIMEN

Sleep period 12 M. to 6 A.M.

			Deprivation period					Post-deprivation period			
	Age	Nor-mal	1st Day	2nd Day	3rd Day	5th Day	Means	Means	D_1	D_2	D_3
Boys											
Gailey	8- 0	2.784	2.87				2.81	3.415	.026	.605	.631
Scheylander	8- 2		2.35	2.17	2.55	2.68	2.33	2.494		.164	
Reynolds	8- 0	2.631	3.34	3.10	2.80	2.95	3.04	2.801	.409	—.239	.170
Underwood	13- 2	2.73	2.64	2.97			2.82	2.99	.090	.170	.260
Wolverton	13-11	2.63	2.23		2.20		2.27	2.597	—.360	.327	—.033
Mossman	14- 7	2.467	2.37	2.53		2.55	2.49	2.606	.023	.116	.139
Vrutneski	15- 0	2.053	1.94			1.95	1.95	2.126	—.103	.176	.073
Ankrom	15- 7	3.287	2.61			3.01	2.81	2.916	—.477	.106	—.371
Droz	15- 7	1.862	1.87			1.99	1.93	2.139	.068	.209	.277
Weismann	18- 7	2.821	2.57		2.57	2.56	2.57	2.504	—.251	—.066	—.317
Girls											
McKinstry	6- 0	1.840		1.72		1.88	1.80	2.047	—.040	.247	.207
Hoist	8- 6	1.958		2.00		2.38	2.14	2.150	.182	.010	.192
Sanders	12- 0	1.756		1.75		1.98	1.86	1.927	.104	.067	.171
Haenny	*12- 8*	*1.655*		*1.55*		1.42	1.49	1.643	—.165	.153	—.012
Reno	13- 0	2.130	2.19	2.11			2.15	2.380	.020	.230	.250
Goodman	14- 3	2.378	2.34	2.33			2.33	2.598	—.048	.268	.220
Brown, D.	15- 4	1.68		1.77			1.77	1.686	.090	—.084	.006
James	16- 0	1.64		1.16		1.10	1.13	1.319	—.510	.189	.321
Rayburn	16- 0	2.02	2.29	2.29			2.29	2.289	.270	—.001	.269
Schlotterbeck	16- 9	1.99	2.09	2.07		2.36	2.17	2.268	.180	.098	.278

quency determinations were made following the method adopted in the earlier experiment. At least five readings were made at each sitting.

The children were provided with unexciting games to occupy their time during the extra waking hours, and none of the children was permitted to "doze" although only the younger children during the later nights of the deprivation period showed any marked tendency to get sleepy before midnight. Games such as checkers, toy horseshoes, and card games were provided. If the children started to get boisterous, as they sometimes did, the games were taken away from them for a time.

In general the children engaged only in enough activity to interest themselves and to keep from going to sleep, so we may feel justified in attributing any change in the readings taken during this period to the loss of sleep itself, and not to the activity occupying the extra waking hours.

3. *Results and Conclusions*

Table 12 gives the means of the critical frequency readings for the normal series for the days during the deprivation on which readings were taken, and for the period immediately following deprivation, the "post-deprivation" period. Unfortunately we were unable to test all of the children on the day following the last night of deprivation (V in the table). The means of the post-deprivation period are based on 10 readings taken in two sittings, five readings being taken at a sitting, on the second and third days following the last night of deprivation. The means of all the readings during the deprivation period are also shown in Table 12.

In Column D_1 of Table 12 is shown the extent of increase or decrease from the normal to the deprivation period (the difference between the mean of the deprivation readings and the mean of the normal readings). If this number is positive, the level of the readings has been raised, and the critical frequency limen is higher; conversely a negative number indicates a decrease. D_2 is the difference between the mean of the post-deprivation readings and the mean of the deprivation readings, and D_3 is the difference between the mean of the post-deprivation readings and the mean of the normal readings.

It is observed at once that the trend of the readings is in general

TABLE 13

EFFECTS OF LOSS OF LAST THREE HOURS OF SLEEP ON THE FLICKER LIMEN
Sleep period 9 P.M. to 3 A.M.

		Deprivation period					Post-deprivation period			
	Normal	1st Day	2nd Day	3rd Day	4th Day	Means	Means	D_1	D_2	D_3
Boys										
Gailey	2.784		3.35	3.20		3.28	2.503	.496	—.777	—.281
Scheylander				2.52		2.52	2.503		.017	
Reynolds	*2.631*		2.82	*2.76*		*2.79*	*2.529*	.159	—.261	.102
Underwood	2.73			2.53		2.53	2.613	—.200	.083	—.117
Wolverton	2.63			2.53		2.53	2.616	—.100	.086	—.014
Mossman	2.467		2.51	2.52		2.52	2.491	.053	—.029	.024
Vrutneski	2.053			2.02–		2.02	2.087	—.033	.067	.034
Ankrom	3.287		3.21	3.21		3.21	3.203	—.077	—.007	—.084
Droz	1.862			1.78		1.78	1.629	—.082	—.151	—.233
Weismann	2.821		2.56		2.69	2.62	2.599	—.201	—.021	—.222
Girls										
McKinstry	1.840		2.16		2.05	2.10	2.276	.260	.176	.436
Horst	1.958		2.15		1.87	2.01	1.808	.052	—.202	—.150
Sanders	1.756		1.71		1.53	1.62	1.598	—.136	—.022	—.158
Haenny	*1.655*		1.58		1.34	1.46	1.330	—.195	—.130	—.325
Reno	2.130		2.32		2.30	2.31	2.303	.180	—.007	.173
Goodman	2.578		2.65		2.57	2.60	2.501	.222	—.099	.123
Brown, D.	1.68		1.79		1.60	1.69	1.585	.010	—.105	—.095
Schlotterbeck	1.99		2.33		2.28	2.31	2.437	.320	.127	.447
van Hoose	1.901			1.42*	1.59	1.42	1.503	—.481	.083	—.398

*First sitting.

upward from the normal to the post-deprivation period both for the boys and the girls. While five of the boys show drops from the normal period to the deprivation period, only two show drops from the deprivation period to the post-deprivation period. With the exception of the first boy, who was psychopathic, all of the boys showing increases show increases of no exceptional magnitude. When this trend of the readings from the normal to the post-deprivation period is considered in the light of the day-to-day variations considered in the earlier experiment, the most plausible explanation for the increases would seem to be that in this case as in the former, practice is responsible for the rise in the critical frequency limen. The same general trend is to be noted in the data for the girls. Four of the girls show a drop from the normal to the deprivation period, but only one girl shows a drop from the normal to the post-deprivation period.

However, the small magnitude of most of the positive readings, combined with the relatively large number of negative readings in the D_1 column for the boys, suggests that the loss of sleep has had a noticeable effect in retarding the practice effect shown in the earlier experiment. It was demonstrated in that experiment that in general the increase from the first to the second sitting was considerably greater than from the second to the third. If the mean of the deprivation readings is compared to the second sitting in the normal series, it is clear that a corresponding increase has not occurred. The data for the girls bear out this same interpretation. It appears, therefore, that for both sexes the loss of sleep has slightly retarded the normal effect of practice.

In any case, the effect has not been so marked as we should have anticipated. Furthermore, the readings for all subjects are not actually lower during the deprivation period than during the normal period.

Table 14 gives the sigmas of the normal, deprivation, and post-deprivation readings. Omissions occur where the number of readings was not regarded as sufficient to warrant the computing of a sigma of the readings. Two facts are suggested; first, the effect of loss of sleep is not to increase greatly the variability of the readings during the deprivation period as might have been anticipated; and second, the continuous decrease in the magnitude of the sigmas throughout

TABLE 14

EFFECTS OF LOSS OF THE FIRST THREE HOURS OF SLEEP: VARIATIONS IN FLICKER LIMEN FOR NORMAL, DEPRIVATION, AND POST-DEPRIVATION PERIODS

	Sigmas		
	Normal	Deprivation	Post-deprivation
Boys			
Gailey	0.17		0.13
Scheylander		0.21	0.10
Reynolds	0.08	0.22	0.13
Underwood		0.23	
Wolverton		0.11	0.16
Mossman	0.13	0.09	
Vrutneski	0.13	0.09	0.05
Ankrom	0.32		0.03
Droz	0.12	0.08	0.04
Weismann	0.11	0.12	0.81
Girls			
McKinstry	0.11	0.11	0.05
Horst	0.20	0.16	0.18
Sanders		0.12	0.53
Haenny	0.13	0.08	0.26
Reno	0.20	0.06	0.16
Goodman	0.11	0.12	0.09
Brown			0.09
James	0.11	0.16	0.13
Rayburn		0.05	
Schlotterbeck		0.15	0.05

the whole period for some individuals indicates that the influence of practice in decreasing the variability of the readings has continued throughout the period, although the level of the readings may have been influenced by the effect of loss of sleep. The unusually high sigma for the oldest boy in the post-deprivation period can be attributed to an emotional disturbance resulting from the belief that his inclusion in the experimental group was the only reason for his not being discharged from the institution.

B. EFFECT OF LOSS OF THE LAST THREE HOURS OF SLEEP

1. *Results and Conclusions*

After an interval of five days had elapsed following the last night on which the children retired at midnight, a second deprivation experiment was performed, the children retiring at the customary hours of 9 P.M. and arising at 6 A.M. during the interim. The second deprivation experiment differed from the first only in the time of the sleep period; in this second experiment the children continued to retire at 9 P.M. but were awakened at 3 A.M. After washing and dressing, the children occupied these extra waking hours in playing the same games that they had played in the earlier deprivation experiment. The younger children appeared to have greater difficulty in keeping awake during these early morning hours than during the hours from 9 until 12 P.M. in the first experiment. Readings on the critical frequency limen were taken during the early morning hours from 3 A.M until 5 A.M. and also late in the afternoon on the days shown in Table 13. These early morning readings together with readings taken late at night for some of the boys will be referred to later in the discussion of diurnal variations.

Columns D_1, D_2, and D_3 correspond to the same columns in Table 12. These columns reveal an important difference between this experiment and the one preceding. Whereas only two of the boys showed a decrease from the deprivation to the post-deprivation period in the first experiment, six of them show a decrease from the deprivation to the post-deprivation period in this experiment; although the sleep period was reduced to six hours for five successive nights in the first experiment, while the same reduction occurred for only four nights in this experiment. This difference is accentuated by the fact that the positive readings for the boys in the D_2 column are all small numbers. The case is similar for the girls, and somewhat more striking. While only two of the girls showed a decrease from the deprivation to the post-deprivation period in the first experiment, six of the nine girls participating in this second experiment show a decrease from the deprivation to the post-deprivation period.

While six of the boys show a drop from the normal to the deprivation period in this experiment as compared with four in the first experiment, only two of the girls show a corresponding drop in this experiment as compared with four in the first experiment. It will be noted that all of the boys showing drops in the first experiment show corresponding drops in the second, although this is not true for the girls.

In general, we may say that loss of sleep in the early morning hours has a greater influence in reducing the critical frequency limen than loss of the first three hours of sleep, and that the effect of the former loss persists over a longer period as is shown by numerous negative values in the D_2 column of Table 13, indicating a further drop from the deprivation to the post-deprivation period.

Table 15 brings out the further interesting fact that the loss of sleep, instead of increasing the variability of the reading during the deprivation period, as might have been anticipated, reduced it for four of the boys and four of the girls, and in no case is the increase marked. In all cases but one, where the sigmas are equal, the sigmas are lower for the post-deprivation period than for the normal period, thus showing the practice effect referred to above.

TABLE 15

EFFECTS OF THE LOSS OF THE LAST THREE HOURS OF SLEEP: VARIATIONS IN THE FLICKER LIMEN FOR NORMAL, DEPRIVATION, AND POST-DEPRIVATION PERIODS

	Sigmas		
	Normal	Deprivation	Post-deprivation
Boys			
Gailey	0.17	0.12	0.12
Scheylander			0.15
Reynolds	0.08	0.06	0.08
Underwood			0.09
Wolverton			0.06
Mossman	0.13	0.02	0.10
Vrutneski	0.13	0.02	0.04
Ankrom		0.08	0.04
Droz	0.12		0.05
Weismann	0.11	0.11	0.07
Girls			
McKinstry	0.11	0.15	0.09
Horst	0.20	0.16	
Sanders		0.10	0.10
Haenny	0.13	0.14	0.07
Reno	0.20	0.10	0.07
Goodman	0.11	0.06	
Brown		0.13—	0.06
Schlotterbeck		0.06	0.08
van Hoose	0.09		

While slight variations in the speed of the sectored disc may have occurred during the readings, it is very unlikely that variations of this kind should have occurred in such a fashion as to bring out so consistent a trend.

C. DIURNAL VARIATIONS

1. *Method*

In the second deprivation experiment critical frequency determinations were made on all of the boys during the early morning hours from 3 to 5 A.M. and again late in the afternoon to determine whether any considerable change in the level of the readings might be discovered in the course of a single day. In the first deprivation experiment readings were also made on four of the boys between 10:30 P.M. and midnight and in the afternoons during the deprivation period.

The means of the early morning readings are based upon 15 readings, five readings on three successive mornings of the deprivation period for each boy. The afternoon means are based on 10 readings, five readings on two afternoons for five of the boys, and five readings on one afternoon for the remaining boys. The night readings in the first experiment represent means of 10 readings (two nights), while the afternoon readings are means of from 10 to 20 readings on two to four afternoons.

2. *Results*

The data for the four boys in the first deprivation experiment shown in Table 16 are of little value, since the first boy is not to be regarded as normal, and the last boy was definitely having emo-

TABLE 16

DIURNAL VARIATIONS

Effects of Loss of First Three Hours of Sleep

Subjects	Afternoon	Night	Difference
Reynolds	3.04 (.22)	2.48 (.23)	—.56
Scheylander	2.33 (.21)	2.36 (.18)	.03
Wolverton	2.27 (.11)	2.31 (.08)	.04
Weismann	2.56 (.12)	3.34 (.20)	.78

Effects of Loss of Last Three Hours of Sleep

Subjects	Early morning	Afternoon	Difference
Gailey	3.12 (0.17)	3.27 (.12)	0.15
Reynolds	2.72 (0.10)	2.79 (.06)	0.07
Scheylander	2.50 (0.10)	2.51	0.01
Underwood	2.62 (.13)	2.53	—0.09
Wolverton	2.70 (.13)	2.53	—0.17
Mossman	2.53 (.04)	2.52 (.02)	—0.10
Vrutneski	1.99 (.05)	2.02	0.03
Ankrom	3.04 (.07)	3.21 (.08)	0.17
Droz	1.89 (.06)	1.78	—0.11
Weismann	2.66 (.08)	2.63 (.07)	—0.03

The numbers in parentheses are sigmas of 10 or more readings. Sigmas were not computed for less than 10 readings.

tional disturbances due to "homesickness." It is interesting to observe, however, that both of these conditions produced a marked change in the level of the readings.

During the second experiment the readings of the first boy were less erratic and the last boy was less perturbed emotionally, thinking that the experiment would soon be over and he could go home. The differences of the means of the early morning readings and the afternoon readings during the second deprivation experiment are shown in Table 16. Five of the boys show a decrease and five show an increase, the magnitude of the changes in no case being very considerable. So far as these meager data may be indicative of diurnal variations, it appears that different individuals are affected differently by diurnal changes, there being no consistent increase in the level of the readings for all individuals during the course of a single day that may be attributed to practice. Many of the differences shown in the third column are so small as to be negligible.

Table 17 summarizes the data on the variation differences for both the first and second deprivation experiments. The only point to be observed by an examination of this table is that in general the number of negative variations bears about the same ratio to the total number of variations during both the deprivation experiments as was the case in the normal readings, as shown in Tables 8 and 9. In other words, loss of sleep has neither the effect of noticeably increasing nor decreasing the relative number of negative or positive variation differences. If these variations are due to adaptation effects,

TABLE 17

VARIATION DIFFERENCES DURING DEPRIVATION

Effects of Loss of First Three Hours of Sleep

Boys			*Girls*	
Negative	Total		Negative	Total
6	13	Night		
15	25	Afternoon	15	21
10	22	Aft. Post-dep.	13	23

Effects of Loss of Last Three Hours of Sleep

Boys			*Girls*	
Negative	Total		Negative	Total
11	30	Early morning		
9	14	Afternoon	11	16
12	20	Aft. Post-dep.	3	15

loss of sleep does not appear to have any influence upon these adaptation effects. Dark adaptation, since it would increase the apparent brightness of the flicker patch, should raise the critical frequency limen. The fact that this does not occur in all cases suggests the possibility of a fatigue effect opposed to the adaptation effect. This interpretation, however, is speculative. A more plausible explanation would be to attribute the smaller variations, which are in preponderance, to chance. That is to say that the discrimination of the disappearance of flicker, or fusion, cannot be perfect. The small variations that occur in both directions, because of their relative magnitudes, even though they be small, will in some cases give positive variations and in other cases negative variations, which signify only that the successive discriminations are not in perfect agreement.

3. *Conclusions*

1. Loss of sleep slightly retards the increase in the level of the critical frequency limen in children, which would normally result from practice for some children, while it has no noticeable effect upon the limen for others.
2. The loss of the last three hours of sleep has in most cases a greater effect than the loss of the first three hours in retarding the normal rise in the critical frequency limen due to practice, as is shown by a fall in the level of the limen from the deprivation to the post-deprivation period for both sexes.
3. Loss of sleep does not noticeably increase the variability of the readings as might be expected. For some individuals loss of sleep in no way disturbs the normal decrease in the variability of the readings taken on successive days.
4. Diurnal variations during the deprivation period are small and show no consistent trend for the group of boys.

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SOME FACTORS DETERMINING HANDEDNESS IN THE WHITE RAT*

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Acknowledgments 57

I. Introduction 59

II. The problem 73

III. Experiment I 75

IV. Experiment II 95

V. General discussion of results 113

VI. General summary 115

References 117

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I. INTRODUCTION

In the human field, the problem of handedness has been given considerable attention from the time of Aristotle and Plato onward. This has resulted in a mass of theoretical discussions and experimental studies, which Cuff (1) found totaled well over 500 titles in 1930. Extensive bibliographies on this topic will be found in other reviews (2, 10, 17, 21).

However, the literature on handedness in animals is extremely scant, surely not exceeding 30 articles to date.

Woodruff (22), in 1909, stated with assurance:

> None of the anthropoids, indeed, no other animal except man, shows any preference in the use of either a right or left limb. They are all ambidextrous (or ambisinstrous).
>
> Natural ambidexterity, then, is an arrest of development, while sinistrality is a departure from the normal and indicates some more or less profound interference with the development of the child in ovum.

As late as 1924, Parson (10) stated:

> Since no authentic traces of handedness have been found among animals, even among Quadrumana, we are forced to the conclusion that whatever the immediate anatomical or physiological cause may be, handedness itself is probably in some way the outgrowth of man's intellectual development.

Downey (2) presented a review of work done on human handedness, in which she stated: "Possibly, as has been suggested, the whole problem of inheritance could be much better approached by way of handedness in rats." She also remarked that "the influence of training both general and specific upon handedness performances has not yet received the detailed attention it deserves."

The first experiment on handedness in animals to appear was by Franz (3), in 1913. He tested six monkeys for handedness by having them reach through chicken wiring for food on a platform in front. They were relatively ambidextrous, as Table *A* shows. Only one of the monkeys exhibited a clear hand preference, and that one took only 20 reaches.

Franz also trained one right handed monkey for "20 to 30" reaches with the left hand, whereupon it changed to the use of this hand, leading Franz to believe that "the apparent proneness to the exclusive,

TABLE 4

Monkey	Right reaches	Left reaches
1	208	202
2	21	33
3	89	193
4	3	17
5	28	28
6	70	265

or almost exclusive, use of either hand might be due to any one of a number of extraneous factors, such as the position of the experimenter, his use of the right hand in delivering food, etc." He did not check the validity of this belief himself, and although he recommended such a check, so far as we know, it has not been done to date.

Kellogg (5), in 1933, published the only strictly comparative study of handedness, as the result of observations on a baby female chimpanzee and on his infant son. At the beginning of the experiment, the chimpanzee, then 7½ months old, was left handed, from 8 to 12 months she was largely right handed, and then reverted to left handedness again from 13 to 16 months of age. The child was right handed at 10½ months, but at 15½ and 18½ months was preponderantly left handed. With each subject, if all their reaches were added for the whole (9 months) period of observation, there would be about the same number of right and left reaches. These changes in the handedness of both ape and child occurred without special training. Kellogg concluded:

> "Such findings . . . may either suggest that handedness tendencies because of their inconsistencies are not inborn, or, if you will, that a simple procedure such as that here employed does not adequately measure true tendencies." (He tested with food, toys, etc., immediately in front of his subjects.)

The results of Klüver (6), 1933, threw some light on the problem of handedness in monkeys. He noted that, although preferential handedness was not manifested for pulling in food boxes when the end of the string was placed in the monkey's cage, it was expressed when the end of the string was placed some distance from the cage. In one case, the monkey was right handed when the end of the string was 5 cm. outside of the cage and left handed when it was within the cage.

Kounin (7), 1938, further clarified this matter of handedness in monkeys. He criticized Ludwig, Sarasin, and Cunningham, all of whom had concluded against preferential handedness, because they had used picking up of food as the criterion, a situation in which "unnoticeable posturings and situational expediencies play too important a part." Kounin, himself, used three reaching situations varying in complexity, and found that the degree of preferential handedness manifested was largely dependent upon the nature of the tasks performed—the most effective being those which required a greater degree of difficulty, coördination, and delicate manipulations.

Pike and Chappell (16), working with cats, devised a test situation which required the animal to climb a vertical screen, to which it held with three paws while stretching for food with the fourth. Other non-handedness, motor tasks were also used. The cats were tested before and after operations, in which lesions were made in the cerebral cortex. Transfers of handedness to the opposite member were produced in the apparatus. In one left-pawed cat, the operation consisted of a lesion about ¼ inch wide and ⅜ inch deep in the arm area of the right motor cortex, with no tissue being removed. When this animal was tested six weeks later it was found to be completely right handed, although appearing perfectly normal to the casual observer.

Handedness in rats has been noted by several students in observing the animals in those types of Richter activity apparatus where food must be obtained by reaching with an arm. In 1930, Yoshioka (23, 24), Tsai and Maurer (19), and the following year, Peterson (11) developed reaching situations to test it. These papers, in so far as they are pertinent to the present experiment, will be described below.

Yoshioka (23, 24) devised an apparatus which forced the rats to reach for food through an inch-square hole in the hardware cloth (wire mesh) flooring. Two hundred animals from 2 to 18 months of age were tested, with the following results: 96 were right handed, 95 were left handed, and nine were ambidextrous.

To be counted as a reach, food actually had to be conveyed to the mouth. In a similar manner, the present experimenter will require all reaches to be functional. Yoshioka's criterion for ambidexterity was extremely subjective. To quote:

> If one hand was used as often as the other, during the two

> test periods of two minutes each, the rat was classified as ambidextrous. . . . In some cases the difference between the frequencies of the use of two hands was so slight that some doubt arose as to the classifications of such rats. If a right hand was used not only slightly more frequently than the left but also more effectively . . . the rat was classified as a right hander, otherwise it was ambidextrous.

It is unnecessary to point out the objection to such a loose classification which does not allow of a check by other experimenters.

Yoshioka believed that a preferential use of one hand may have originated from the better development of that arm. Bones of the rats' fore limbs were measured under a low power microscope. The absolute differences were not reported, but probably were very slight. Table *B* is derived from his data.

TABLE *B*

	Right handers	Left handers	Ambidexters	Totals
Right fore limbs longer	36	0	0	36
Left fore limbs longer	0	45	0	45
Limbs equal in length	60	50	9	119
Totals	96	95	9	200

The conclusions of Yoshioka may be considered somewhat questionable. In the first place, the extra length found in the handed forearm of his animals might well be the result, rather than the cause of the handedness. Second, the extra bone length might be an hereditary concomitant of handedness and be neither the cause nor the effect. Definite evidence of the falsity of Yoshioka's hypothesis will be developed in the main body of the present experiment, where it will be shown that rats are often right handed on one apparatus and left handed on another.

Tsai and Maurer's test situation was similar in general to that of Yoshioka's—it being a wire cage with a small glass bottle containing wheat embryo inserted through the wire bottom. The opening of the bottle was so small (¾ inch in diameter) that it permitted the rat to use only one hand at a time for grasping and lifting the food out of the container. Since both cage and opening of the bottle were circular, there existed apparently no environmental situation tending to favor the use of either hand.

TABLE *C*

	Normal rats						Vitamin B depleted						Combined groups					
	% ♂	No. ♂	% ♀	No. ♀	Total %	Total No.	% ♂	No. ♂	% ♀	No. ♀	Total %	Total No.	% ♂	No. ♂	% ♀	No. ♀	Total %	Total No.
Right handed	**59**	35	**43**	20	52.4	55	**48**	13	**33**	9	40.8	22	55.8	48	39.7	29	48.4	77
Left handed	**26**	15	**37**	17	30.5	32	**48**	13	**45**	12	46.3	25	32.6	28	39.7	29	35.9	57
Ambidextrous	**15**	9	**20**	9	17.1	18	**4**	1	**22**	6	12.9	7	11.6	10	20.6	15	15:7	25
Totals	100	**59**	100	**47***	100.0	105	100	**27**	100	27	100.0	54	100.0	86	100.0	73	100.0	159

**Bold faced* figures are those supplied by Tsai and Maurer. Note that this number "47" must be wrong, or else that the percentages given are incorrect.

These workers were testing the effects of Vitamin *B* depletion on the handedness of rats. Using a criterion for ambidexterity of 26-74 per cent reaches with one hand, they obtained the results given in Table *C*.

As a majority of the normal rats were right handed, they concluded that "This discovery throws light on the phylogenetic evolution of handedness and at the same time overthrows the theory of outgrowth of human intelligence, the theory of primitive warfare, and the theory of social tradition." This appears to be a rather sweeping generalization to draw from so few data. Moreover, chance is not excluded when the Chi-Square test is applied to their results, *P* being about 5 in 100 that the differences could have arisen by chance. Tsai and Maurer also believed that the differences between the normals and the Vitamin *B* deprived rats, and those between the sexes were reliable. Chi-Square analysis gave a *P* between 10 and 20 in 100 for the former, between 20 and 30 in 100 between normal males and females, and between 10 and 20 in 100 between vitamin deficient males and females. They recommended that attempts be made to modify handedness by shocking, or paralyzing by drug or operation. The possibility of modification by mere practice apparently did not occur to them.

Peterson (11) used a canary feeding dish of the T-type to test the handedness preferences of seven rats. This apparatus, called the Peterson Testing Apparatus in the main body of our study, is shown in Figure 1, *C*. Four rats were found to be predominantly right

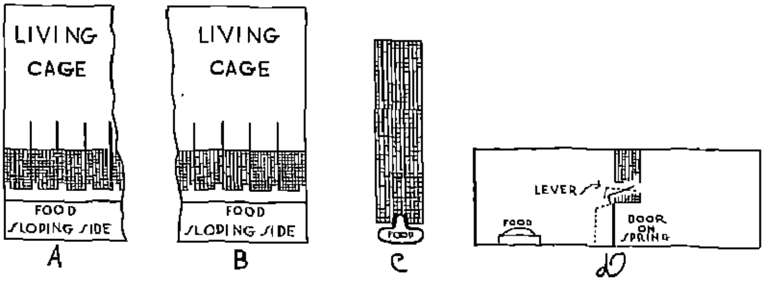

FIGURE 1

A. Floor plan of Wentworth training apparatus for right hand. *B*. Floor plan of Wentworth training apparatus for left hand. *C*. Floor plan of Peterson testing apparatus, used to test hand preferences. *D*. Side view of latch box, with final (shortest lever which calls for manual depression).

handed, two predominantly left handed, and one, which took 309 *right reaches out of 400, was considered ambidextrous.* They were then subjected to removal of the motor and somesthetic region of the contralateral hemisphere of the cerebral cortex. As a result of the operations all animals, except one, transferred either abruptly or gradually to the use of the other hand, as indicated in Table *D* which was derived from his data.

TABLE *D*

Rat No.	Before operation No. reaches Right	Left	% right reaches	After operation No. reaches Right	Left	% right reaches	% of change
1	289	11	96.33	1	599	0.17	96.16
2	250	0	100.00	2	548	0.36	99.64
3	250	0	100.00	3	547	0.55	99.45
4	1	249	0.40	511	39	92.91	92.89
5	309	91	77.25	65	485	11.82	65.43
6	11	289	3.67	99	901	9.90	6.23
7	150	0	100.00	62	488	11.27	88.73

He made an histological check of the brain areas affected by the operations and concluded that extensive destruction of the motor and somesthetic fields opposite to the preferred hand leads to a transfer in handedness. These results are similar to those reported on cats by Pike and Chappell, as noted above.

It has been suggested that handedness may be due to the asymmetrical *arrangement of the carotid arteries which supply the brain.* This theory of cerebral dominance was tested by Peterson (12), who ligated the left carotid of nine rats, and the right carotids of nine others. Only six of the 18 cases developed hand preference on the same side as the ligation, as the theory demands. He concluded that "dominance of one hemisphere of the brain of the rat as revealed in food reaching is not due to unequal blood supplies coming from the two carotid arteries and that, until positive evidence is forthcoming, the explanation of cerebral dominance in man in terms of differences in the mode of origin of the two carotids should be regarded skeptically."

The best and most exhaustive experiment on *handedness in the rat* is that of Peterson (13) in 1934, in which he raised and attempted to answer the following questions: (*a*) What is the relative incidence of right and left handedness in large numbers of rats? (*b*) Will the animals be consistent in the use of their hands over relatively long periods of time? (*c*) Can other situations be devised to test handedness or laterality, and if so, will animals that are right handed in a food situation also show a preference for the use of the right hand in these other situations? (*d*) Will rats which are ambidextrous in a food situation eventually show greater preference for one hand, or is ambidexterity a relatively consistent trait? (*e*) Can heredity, rather than practice, be the factor causing handedness? (*f*) Is eye dominance the factor? (*g*) What are the cerebral mechanisms involved in handedness? (*h*) Is re-education possible after the destruction of a critical area?

(*a*) His data on incidence are reproduced in Table *E*.

TABLE *E*

	Right		Left		Ambidextrous		Total	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Males	20	33	31	50	10	17	61	100
Females	22	37	31	53	6	10	59	100
Total	42	35	62	52	16	13	120	100

The rats were selected from a large colony at random. Peterson's criterion for ambidexterity was failure to show preference in two successive tests. He did not count the number of reaches made. He concluded that "three varieties of handedness are found in the rat, namely, right handedness, left handedness, and ambidexterity." He believed it probable, on the basis of breeding studies, that right and left handedness occur in about equal numbers and ambidexterity much less frequently. He pointed out that no more definite conclusion should be given until several coöperating investigators working in different laboratories and employing the same criteria (and we would add, using several tests) report congruous results for large random samplings of animals.

(*b*) Eleven rats which were either right or left handed were tested for more than seven months and found to remain consistent.

(*c*) A latch box was constructed and a water-tank device was used for further tests of handedness. His latch box was used in the present experiment, and is shown in Figure 1, *D*. He found that it also differentiated rats into right and left handed, but four of the seven animals tested were not consistent in the use of their hands in the two situations. This inconsistency led him to conclude that handedness in the rat is not a simple characteristic. The water tank apparatus did not seem to be a discriminative instrument.

(*d*) In most cases, the ambidexterity of the animals did not seem to be fixated to an exclusive preference for one hand by a greater amount of practice with that hand. Some remained ambidextrous, while others eventually shifted to the use of one or the other hand, and yet not necessarily to the hand used preponderantly. This led Peterson to conclude that "practice, i.e., chance and previous experience," was not the predisposing factor in determining handedness.

(*e*) The heredity factor was tested in two ways. First, right handed animals were bred with right, left with left, and others in various combinations. When neither right nor left bred true, the offspring were inbred for seven[1] generations without any change appearing in the handedness relationships. Inasmuch as Peterson had found that handedness varied in the individual from one apparatus to another, the genetic character of this trait would seem to be quite improbable.

(*f*) The hypothesis has been expressed by Parson (10) 'that the preferred hand is dependent upon the dominant eye. Peterson removed or enucleated one eye of each of 10 rats when only 14 days of age, i.e., before the eyelids had separated. Of six animals having the right eye nonfunctional, two were right handed, three left handed, and one ambidextrous. All four having the left eye nonfunctional were left handed. Thus the results of seven of the ten animals contradicted the theory. Peterson recognized that these results did not preclude the possibility that dominance of the eye and of the hand may both be reflections of some other cause. We might again point out the futility of checking eye dominance against handedness as measured by a single apparatus.

(*g*) Peterson found the cerebral mechanism involved in handedness to be definitely localized in the frontal area of the contralateral hemisphere. This area may be roughly located by electrical stimulation. While destruction of this area, amounting to less than four per cent of the area of one hemisphere, led to permanent transfers in the preferential use of the hands, yet destruction of 50 per cent of the hemisphere outside of the handedness area did not affect the preference, nor did lesions in any part of the homolateral hemisphere. When the critical areas of both hemispheres were destroyed, most of the animals continued to show preference for the originally preferred hand, and although extremely awkward at first, gradually improved with practice. Thus there seems to be an asymmetrical mechanism which is "extra-pyramidal," subcortical, or both.

---

[1] Peterson has since carried this procedure through 10 generations with no different results (unpublished).

In Experiment 2 of the present study the progeny of 14 right or left handed mothers (preference of father unknown) showed a chance relationship with the preference of the mothers. This was true even of four mothers who showed the most extreme handedness, when tested in four different types of apparatus.

(*h*) Peterson forced reaching practice with the hand whose contralateral handedness area had been insulted, by binding with adhesive tape, for three days, the hand used after the operation. Results were rather negative as three of the four rats tested returned to the use of the hand transferred to after the operation. The fourth became, and remained, ambidextrous. It is scarcely necessary to point out the objection to the use of this method of forced practice. Peterson, himself, points out that all four animals showed decided weakness in the bound arm. We have previously (20) described an improved method which circumvents this objection.

Milisen (9) raised and attempted to answer the following questions. (*a*) Can handedness be explained merely on the basis of habit formation? (*b*) Is handedness more difficult to influence in older than in younger rats? (*c*) Is the handedness of females more or less easily influenced than that of males? (*d*) Does peripheral deficiency influence handedness preference? (*e*) Does the "circular-cage test" (a modification of Tsai and Maurer's apparatus) adequately measure the effect of training which the rats receive in the training cage (see below for description)? (*f*) What variations in handedness appear as a result of training?

Besides the Tsai and Maurer modified apparatus test, a cage was constructed, which consisted of square-passageways "large enough to permit the rat to crawl in without being too crowded, but too small to allow it to turn around while in the cage" and eight inches long. A ½-inch slit in the floor containing food, ran transversely across the passage. The training cage was essentially the same except for the placement of the slit, which was now cut to run parallel to the passage, either on the extreme right or left side, according to the experimenter's desire to train the right or left hand. The principle of Milisen's training apparatus resembled that of ours in that the rat was restrained from reaching with one hand because of the relation *of the position of the body to that of the food.* It varied from ours chiefly in requiring the close confinement of his animals. It can be *readily seen,* however, that if his animals were successful in turning around in the passageway, it would be disastrous to clear-cut results, as they would then be getting forced training *with the undesired hand.* Those familiar with the agility of rats can recognize this danger.

Milisen tested the six questions above by performing the following five experiments. His conditions and results will be reported rather fully because some of the latter were so diametrically opposed to ours (20).

1. Nine male rats one year old were tested for handedness preference and then trained with the non-preferred hand for nine months (approximately 90,000 prehensions). In spite of this protracted training, they all retained their original handedness.

2. Six males and seven females were forced to feed with their left hands from the time they were three months up to the time they were six months of age. They were tested after each month of training. Four males and five females were left handed at each testing, with two males and two females still resistant to the training. At the end of the third month, they were forced to eat with the right hand for three months. One of the four left handed males shifted, *and two of the three left handed females still alive shifted.*

3. Three right handed males, one ambidextrous male, and one right handed female, all three months old, were given four months of left training. At the end of the fourth month one male was still right handed, and a male and a female were ambidextrous.

4. Five males and four females, when newly weaned (23 days old), were given training for two months. There was then a right handed female, an ambidextrous male, and all the rest had become left handed. When given four months of right training, three females were right handed, one left, one male was right handed, and four were left.

5. Four rats were tested for preference, and the middle digit of the preferred hand amputated. After four months of no forced training, they had all retained their original preferences.

From these experiments, he concluded that not all handedness in rats can be changed by training, and therefore that neither habit formation nor innate tendencies alone suffice to explain handedness, but rather an interaction between them, with "native sidedness" the more powerful factor in the majority of cases. He also concluded that older rats and males seemed more fixed in their handedness than others.

In comparison with these results, we (20) gave nine 23-day-old rats and ten 35-day old rats 14 and 21 days forced practice respectively with their right hands. Ninety days later all 19 were right handed, 15 of them so thoroughly so that they did not take one left reach in 175 trials. In fact, these 19 rats took only 26 left reaches in 3,325 preferential reaches.

The only supposition which we can advance for Milisen's strikingly negative results is the possibility mentioned above that his apparatus may have allowed reaches with the hand undesired by the experimenter. If this were true, it might account for the anomalous reaction in which one of his rats developed right handedness while being trained in the use of the left hand. Since he does not give a diagram to his apparatus, it is impossible to be certain about his training conditions.

Lei (8), in studying the length of time rats could hang before fatigue caused them to let go, noticed that when the animals were about to fall off (one of their fore feet was always released first, the animals falling a few seconds later. Observations on this "footedness" phenomenon are recorded in Table *F*.

TABLE *F*

	Right footed		Left footed		Neutrals		Totals
	No.	Percentage	No.	Percentage	No.	Percentage	No.
Males	18	30.0	7	11.7	4	6.7	29
Females	15	25.0	15	25.0	1	1.6	31
Totals	35	55.0	22	36.7	5	8.3	60

Lei used the same criterion of ambidexterity as Tsai and Maurer (26-74 per cent of reactions with one hand). When he accepted 90 per cent as a minimum consistency for footedness, there still remained 27 right footed and 17 left footed rats. He believed that his data revealed true sex difference. To quote: "The male rats are more likely to be 'right-footed', or to be neutral in a much less degree, while the female ones tend to be 'left-footed'." He did not attempt to use any reaching techniques on these rats, and so the relationship between the holding-on reaction and other tests of handedness is as yet unknown.

Thus we see that not only is the animal work on handedness rather sporadic but also that the students in the field differ rather widely in their conclusions. The hereditary basis of handedness, sex difference, the effect of diet, the influence of eye dominance, the effect of different kinds of reaches are a few of the areas in which there is wide disagreement. Also, the influence of training on handedness is found to be quite slight by Milisen and extremely potent by the present author in an earlier study.

II. THE PROBLEM

The present study was designed to clarify some of the contradictory and ambiguous results that have been reported by other investigators, as noted above.

Our study is composed of two separate experiments. Experiment 1 was performed in the animal psychology laboratory of the University of New Mexico, during the period from May, 1937 to September, 1938; while Experiment 2 was done in the Columbia University animal psychology laboratory from March to July, 1939. Experiment 1 evolved from the original experiment previously reported (20) and Experiment 2 was planned with reference to the results secured in Experiment 1. Because of this, and also for the sake of clarity and convenience, each part will be treated separately.

The general aim of the study was to determine the effects of practice on hand preference in various test situations. This involved the training of groups of white rats on one or another of the types of apparatus indicated in Figure 1 (*A, B*), which forced the animals to reach for food with the hand selected by the experimenter. In some groups, the animals had been previously tested for natural preference and were required to use the non-preferred hand. In other groups, the animals were trained to use a given hand arbitrarily without being tested as to natural preference. The main variables studied were as follows: (*a*) age at which training was given, (*b*) amount of training given, and (*c*) length of interval between the period of training and the test for handedness.

It may be pointed out here that there is an inherent difficulty in the type of experimentation here employed. This relates to the matter of determining the natural preference of the animal without influencing this preference by the means employed to determine it. If we make use of even a short test (as we have done) to ascertain the original preference, we cannot be sure that some training is not involved. It is difficult to know where "testing" leaves off and "training" begins. If the test is made too short, however, there is the danger that a dependable index of natural preference has not been secured. Obviously, if such a test is omitted altogether, the specific preference of the individual animal remains unknown. This criticism does not hold for group results, however, since the ratio of right and left hand preference for the white rat is fairly well established. But even here the ratio differs from one report to another because of divergence in procedure, criteria of handedness, and the like. As will be seen, we have utilized both methods of approach from time to time. When following the plan of determining the natural preference before training, we have kept the test period as short as seemed feasible and still give a dependable index of preference. The possible influence of "testing" on the later "training" period has thus been kept at a minimum.

III. EXPERIMENT I

A. PROBLEMS

The aim of this experiment was to throw light on the following questions: (*a*) What is the effect of giving different amounts of *left*-hand training to the offspring of rats which were all *right*-handed after right-hand training? (*b*) Is the age level at which forced practice is given a factor in the development of handedness? (*c*) Is handedness preference established by training retained for long periods of time? (*d*) Is the preference a specific one or is it a general trait? (*e*) Are there any reliable sex differences in handedness? (*f*) Does ambidexterity throw any light on theories of handedness? (*g*) Does eyedness correlate with or determine handedness? (*h*) What is the effect on handedness habits that have been established of forced practice with the opposite hand?

B. ANIMALS

One hundred thirty-five albino rats, offspring of the 19 rats previously (20) reported on, were used here. The parental group had all been right handed either naturally or after forced pracitce. During the course of the experiment six animals died, so that data on only 129 were obtained. These rats were bred from University of Chicago Wistar Institute strains. Ten animals were blind in one eye, due to a genetic or developmental defect which caused the eye to be lacking, and gave evidence bearing on Question *g* above.

The regular food given to the animals in the home cages was the same as that used in the training and testing situations. In each case, it was chicken growing mash called by the trade name, "Growena." It is manufactured by the Ralston Purina Co. of St. Louis, Mo., and is well-balanced ration, containing dried buttermilk, codliver oil, sardine oil, meat scrap, fish meal, soy-bean oil meal, wheat germ, alfalfa meal, corn meal, beet pulp, wheat middlings, wheat bran, calcium carbonate, and iodized salt. It was served as a dry, coarse powder, unmixed with water. The animals were given continuous training for various intervals of time in modified living cages (Figure 1, *A* and *B*). All tests were conducted in the late afternoons and evenings.

C. APPARATUS

Figure 1 (*A* and *B*) shows the ground plan of portions of the Wentworth apparatus used in right and left hand training. Each apparatus had nine stalls, two inches wide, in which food could be obtained. In Apparatus *A*, successful reaches could be made only with the right hand, whereas in Apparatus *B* only left hand reaches could be made. This is brought about by the placement of the food slot in either the right or the left corners of the stalls. The author has observed several hundred reaches taken by rats in this apparatus, and has *yet to see a successful right reach in the apparatus designed* to force left reaches, or vice versa. Most rats never attempt an inappropriate reach and the small percentage that do usually desist after one reach in which the hand bumps against the wire mesh wall or the wall of the food slot. A sloping side in front of the stalls was designed to allow the food to slide down as it was used. However, this was only partly successful as the powder sometimes became packed and had to be pushed down by the experimenter.

The ground plan of the Peterson testing apparatus is shown in Figure 1 (*C*). It is so designed as to make reaching with either hand to secure food equally easy, so far as the plan of the apparatus is concerned.

The latch box (Figure 1, *D*) has previously been described by Peterson (14). The hungry rat is placed in the right-hand compartment of the apparatus, separated from the food compartment by a spring door. This door is opened by the rat and it gets food when it accidentally trips a lever projecting into the right-hand compartment above the door. Any part of the rat's body may serve to depress this lever at this stage in the learning process. Later, the lever is replaced by others progressively shorter. The next-to-shortest lever does not extend quite into the right compartment and can be tripped only by one or both of the rat's front feet or its mouth while it is standing on its hind feet. The shortest lever can be depressed only by a single front foot.

A, *B*, and *C* of Figure 1 show apparatus requiring the direct reaching for food, whereas the latch box, shown in *D*, allowed food to be reached only indirectly after depression of the lever has caused the door to spring open. The first three types of apparatus have floors made of hardware cloth (wire mesh), at least around the food containers. This arrangement allowed surplus food to fall through, and thus prevented the animals from securing food except when actually reaching.

D. Procedure

The same general procedure was used in all of the problems indicated above under "Problems," i.e., a period of forced training in the Wentworth apparatus was followed by tests in the Peterson apparatus. The only differences were in such factors as age at which training was given, amount of training given, and the interval between training and testing. Certain minor differences in conditions from group to group are clearly indicated in the statement of the problems at the beginning of this chapter.

In the determination of what movements constituted a genuine reach in the Peterson apparatus, we accepted the practice of Yoshioka, who counted only those reaches which were successful in obtaining *food and transporting it to the mouth. Frantic pawing and scratching*, which sometimes occurred with a few rats, were disregarded. Of course, in the latch box situation, where food was not reached for directly, this criterion could not be used. There, a reach was counted when the shortest lever was depressed enough by the hand to cause the door to open.

"One day's reaches," as here used, refers to the total number of reaches taken by the rat in a period of 24 hours. According to Milisen (9) this is the equivalent of from 300 to 500 reaches. However, we can understand that this might vary considerably according to the consistency of the food used and the frugality or wastefulness of individual rats being tested.

This experiment begins by first training the animals and only later *testing them to determine their handedness. The test for handedness* on the Peterson apparatus consisted of 175 reaches—25 a day for 7 days. The criterion of handedness employed was as follows: 0-47 reaches out of 175, left handed; 48-127, ambidextrous; 128-175, right handed. Thus, if the rat makes 73 per cent of its reaches with the left hand it is considered left handed; if 73 per cent with the right hand, it is called right handed, and if the score falls between these points, it is regarded as ambidextrous. Two reasons are advanced for accepting these points for classification. They agree fairly well with the criterion of Tsai and Maurer (19) and Lei (8), who accepted 74 per cent as the dividing line. Secondly, our data (175 reaches) were found to break down into well-balanced groups of reasonable size at the 73 per cent point. As a matter of fact, the use of a 74 per cent instead of a 73 per cent criterion would not have changed the distribution of handedness in the categories as none of the rats took either 47 or 128 reaches with the right hand. Hence we see that the groups were clear cut on the basis of the criterion used.

In Table 1, we have gathered together the results of the incidence of handedness reported by several investigators for purposes of comparison. We find a remarkable degree of agreement between the four reports. This agreement is the more remarkable when we remember that the types of apparatus, the strains of rats, the length of tests, and the criteria of handedness varied from experimenter to experimenter. The only point of wide divergence is with Yoshioka who found only 4.5 per cent of ambidexterity as against a range of between 13.3 per cent and 17.2 per cent of the others. His results are not based on the method of accurate counting of reaches by the others as shown above in the introduction.

TABLE 1

Incidence of Handedness in Untrained Rats

Investigator	Right handed		Left handed		Ambidextrous		Totals
Yoshioka	96	48.0%	95	47.5%	9	4.5%	200
Tsai, Maurer	77	48.4%	57	35.9%	25	15.7%	159
Peterson	42	35.0%	62	51.7%	16	13.3%	120
Wentworth*	41	39.0%	46	43.8%	18	17.2%	105
Totals	256	43.8%	260	44.5%	68	11.7%	584

*Data from Experiment II, to be reported in a later chapter.

E. Results: Part 1

The main variables studied were as follows: (*a*) amount of training given; (*b*) age at which the training occurred; (*c*) the interval between the training and the test for handedness. Since there were so many combinations of these variables among the 27 groups tested, it seems best to indicate the conditions in tabular form (Table 2). The results obtained have been arranged in Table 3, which shows the number and percentage of rats which were left handed after being

TABLE 2

EXPERIMENTAL CONDITIONS

1. Groups of 5 rats each	2. Age in days when left training given	3. Days of left training	4. Non-training interval (days)	5. No. rats tested
A	25	1	90	5
B	25	2	90	5
C	25	7	90	5
D*	25	1	180	4
E*	25	2	180	4
F	25	7	180	5
G	25	1	270	5
H	25	2	270	5
I	25	7	270	5
J	50	1	90	5
K	50	2	90	5
L	50	7	90	5
M	50	1	180	5
N	50	2	180	5
O	50	7	180	5
P*	50	1	270	4
Q	50	2	270	5
R	50	7	270	5
S	90	1	90	5
T	90	2	90	5
U	90	7	90	5
V**	90	1	180	3
W	90	2	180	5
X	90	7	180	5
Y	90	1	270	5
Z	90	2	270	5
ZZ*	90	7	270	4
Total				129

Each asterisk refers to the death of one subject. The "days" of left training indicated in Column 3 consisted of 24 hours each. The test indicated in Column 5 involved 175 reaches for all groups (25 reaches a day for 7 days).

subjected to these varying conditions. It is interesting to compare the percentages appearing in this table with those in Table 1, in which the different investigators have reported the incidence of handedness on untrained rats. Apparently, rats uninfluenced by training are about 44 per cent left handed. The data of Table 3 indicate that, out of 129 rats trained, 112 or 86.8 per cent were left handed. Thus, the training seems to have practically doubled the incidence of left handedness. This shift occurs, regardless of whether the training occurs in infancy (25 days) or adulthood (90 days), and even when as little as one day's training is given. At least 80 per

TABLE 3

SHOWING THE EFFECT OF AMOUNT OF LEFT TRAINING, TRAINING AGE, AND INTERVAL BETWEEN TRAINING AND TEST PERIODS, IN CAUSING LEFT HANDEDNESS IN 129 RATS

Training age in days	Interval between training and test for handedness																		Totals	
	90 days						180 days						270 days							
	1*		2		7		1		2		7		1		2		7			
25	3	60%	3	60%	4	80%	4	100%	4	100%	5	100%	3	60%	4	80%	5	100%	35	81.4%
50	4	80%	5	100%	5	100%	5	100%	5	100%	3	60%	4	100%	5	100%	4	80%	40	90.9%
90	5	100%	5	100%	5	100%	1	33%	4	80%	5	100%	5	100%	4	80%	3	75%	37	88.1%
Totals	12	80%	15	87%	14	93%	10	83%	13	93%	13	87%	12	86%	13	87%	12	86%	112	86.8%
Grand totals			39		86.7%				36		87.8%				37		86.1%			

*The values in this array refer to the number of days of left training.

cent under each condition were left handed after the training, as shown in the totals arrays in Table 3.

The factor of "interval between training and the test for handedness" is *manifestly ineffectual*, within the limits tested, since the percentage of left handed animals for the three intervals of 90, 180 and 270 days is practically the same, being respectively 86.7, 87.8, and 86.1, as shown in Table 3. It seemed feasible, therefore, to combine the values for all intervals so as to eliminate that factor and thus simplify the data.

When this is done, the results of Table 3 may be condensed into the form shown in Table 4. This allows the other two factors (age and amount of training) to stand out for separate analysis. The variation in the training age, from 25 to 50 to 90 days, effects a change in incidence of something less than 10 per cent, as shown in the totals column of Table 4.

TABLE 4

SUMMARY TABLE DERIVED FROM TABLE 3 WITH THE DIFFERENT INTERVALS BETWEEN TRAINING AND TESTING COMBINED

Training age in days	Number of days of left training							
	1		2		7		Ave. totals	
25	10	71%	11	79%	14	93%	35	81.4%
50	13	93%	15	100%	12	80%	40	90.9%
90	11	85%	13	87%	13	93%	37	88.1%
Ave. totals	34	82.9%	39	88.6%	39	88.6%	112	86.8%

Apparently, early training (25 day age level) is somewhat less effective in inducing handedness than is training at the later age levels (50 days, 90 days). This result is contrary to what might be expected in view of the general opinion that early training is most effective in the formation of movement patterns.

The factor of amount of training given is considerably less effective than that of the age of training factor, the latter showing an increase of from 81.4 to 90.9 per cent as the age at training increases from 25 to 50 days, its maximum value. Although we know that practice is effective in causing handedness, because of the high percentages occurring throughout Table 4, yet a further increase in amount of training over the minimum of one day is apparently relatively inconsequential, as an increase from 82.9 to 88.6 per cent in the totals arrays indicates. An analysis of the table shows that the percentage of rats trained at 25 and 90 days of age increased in left handedness as the number of days of left training increased from 1 to 2 to 7. This trend did not hold with the 50-day-old group—all 15 of those receiving two days' training becoming left handed.

On the whole, we should say that neither age nor amount of practice seems to be of much importance within the limits tested. As little as one day's training given at weaning (25 days), puberty (50 days), or adulthood (90 days) is successful in increasing the handedness to about the same point, whereas twice the amount of training (two days) or even seven times the amount (seven days) has little or no further effect. Moreover, the effect of such training is retained for at least 270 days, which is probably nearly half of a rat's normal life expectancy. It is doubtless effective for even longer periods, since the percentage of rats left handed after the longest period (270 days) showed practically no diminution in preference.[2]

The question now arises as to whether the differences noted above are statistically reliable. It is undesirable to compute reliabilities on the several values of Table 4 because several factors have been varied simultaneously. For example, a total score of an age level involved variations in interval and also in amount of training. Furthermore, if the different factors were separated out into the 27 original groups the latter would be too small for the computation of reliability (Table 2). It seemed best, therefore, to apply Fisher's technique for the analysis of variance to the data as a whole.

The problem constitutes a 3-way analysis of variance. Table 5 enables us to obtain the Total Sum of Squares. The data of this table is then rearranged into the three 2-way tables (Tables 6, 7, 8) from which we may calculate our three main effects and the three simple interactions which we wish to partial out.

Table 6 is a 2-way table which will give us the interaction of the Intervals with the Training Ages. It is set up to disregard the effect of the Number of Days of Training, inasmuch as each entry denotes the sum of *D*1, *D*2, *D*7 in Table 5.

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[2] Another indication of the lasting effect of training is the following: of the 19 rats which were parents of the present subjects, 11 were still alive *12 months after having been made right handed by training*, and *all 11* of these animals, upon being retested, were found to be still right handed.

TABLE 5

SHOWING THE NUMBER OF RATS OUT OF EACH GROUP OF FIVE WHO BECAME LEFT HANDED

Training age in days	Days of training	90 days	Intervals 180 days	270 days	Sums
25 days	D_1	3	5*	3	11
	D_2	3	5*	4	12
	D_7	4	5	5	14
50 days	D_1	4	5	5*	14
	D_2	5	5	5	15
	D_7	5	3	4	12
90 days	D_1	5	1.67*	5	11.67
	D_2	5	4	4	13
	D_7	5	5	3.75*	13.75
	Sums	39	38.67	38.75	116.42

*The numbers marked by asterisks were determined for those groups where the number of animals was reduced by death to fewer than five as follows. If only one rat died, leaving four in the group, and if all four became left handed, then the entry is 5. This involves the assumption that the same incidence of occurrence would have been obtained if the original five rats were still alive. Thus $4/4=x/5$, and solving for x, we get $x=5$. Another example: when two rats died, leaving three in the group, and if only one rat became left handed, we get the entry as follows: $1/3=x/5$, and solving for x, we get $x=1.67$.

TABLE 6

INTERACTION OF INTERVALS BETWEEN TRAINING AND TESTING WITH TRAINING AGES

Training age in days	90 days	Intervals 180 days	270 days	Sums
25	10	15	12	37
50	14	13	14	41
90	15	10.67	12.75	38.42
Sums	39	38.67	38.75	116.42

TABLE 7

INTERACTION OF INTERVALS BETWEEN TRAINING AND TESTING WITH NUMBER OF DAYS OF TRAINING

Number of days of training	90 days	Intervals 180 days	270 days	Sums
D_1 (one day)	12	11.67	13	36.67
D_2 (two days)	13	14	13	40
D_7 (seven days)	14	13	12.75	39.75
Sums	39	38.67	38.75	116.42

TABLE 8

INTERACTION OF TRAINING AGES WITH NUMBER OF DAYS OF TRAINING

Number of days of training	Training age in days 25 days	50 days	90 days	Sums
D_1	11	14	11.67	36.67
D_3	12	15	13	40
D_7	14	12	13.75	39.75
Sums	37	41	38.42	116.42

Table 7 is a 2-way table which will give us the interaction of the Intervals with the Number of Days of Training. Each entry denotes the sum of the scores for all three training ages in Table 5 and thus serves to disregard the effect of the training ages.

In like manner, Table 8 is a 2-way table derived from Table 5. Each entry here denotes the sum of the scores for all three Intervals, and thus disregards the effect of those Intervals, while allowing us to obtain the interaction of the different Training Ages with the different Number of Days of Training.

The F values given in the summary table of results (Table 9) are computed with the triple interaction taken as the estimate of experimental error. The reason for this is that we wish to be able to draw the most general conclusion we can about the observed variances of our three experimental factors (namely, Intervals, Training Ages, and Lengths of Training). The argument is analogous to that of Goulden (4) in his consideration of a similar analysis of a 3-factor experiment.

The F values show that, using the triple interaction as the experimental error, none of the differences observed in our data is significant. The 5 per cent and 1 per cent values of F have been entered only in the case of one of the interactions (which turns out to be not significant) because all the other F's are smaller than 1.00, hence automatically show that the variances being tested are *smaller* than experimental error. This would seem to point toward some factor or factors having *inhibited* the variance, especially in the case of the Intervals, where the variance is significantly less[3] than the experimental error variance. Just what this factor or factors could have been is unknown to the author.

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[3] See Snedecor, *Statistical Methods,* 1938, p. 203, for the method of testing for the significant restriction of variance.

TABLE 9

Summary Table of Results

Source of variations		Sum of Squares	DF	Mean square (Variance)	F	5%	1%
Main effects	Intervals	.0066	2	.0033	.003		
	Training ages	.9138	2	.4569	.42		
	No. days training	.7644	2	.3822	.35		
Simple interactions	Intervals X training ages	7.5643	4	1.8911	1.74	3.84	7.01
	Intervals X No. days training	.8270	4	.2068	.19		
	Training ages X No. days train.	3.0865	4	.7716	.71		
Triple interaction, or remainder (Intervals X training ages X No. days train.)		8.7030	8	1.0879			
Total		21.8656	26				

The writer (20) had originally held an hypothesis that training given earlier in life would be more efficacious than that given later, after possible incidental practice might have affected handedness. This conclusion has been drawn by Milisen (9) as a result of the analysis of his data. However, it can be seen that such is not the case here. In fact, there is even a slight increase in the percentage of left handedness (from 81.4 to 90.9) as the training age was changed from 25 to 50 days, although this difference is not significant, as indicated by the analysis of variance cited above.

In general, our results seem to indicate that heredity is not a factor of much importance in determining the handedness of the rat, at least in so far as this type of reaching is concerned. Otherwise, it is difficult to see why one day of practice by the hand opposite that of the natural hereditary preference would effectively influence the original preference during so large a part of the life cycle.

F. Results: Part 2

We were now desirous of ascertaining whether the rats used above would show the same degree of left handedness in another reaching situation as they had in the Peterson apparatus. The latter is quite similar to the training apparatus, except that the stance of the animals was *to one side or another of the food container instead of directly* in front. The latch box was chosen as the other test apparatus because it requires an entirely different type of reach, in which the animal has to stand on its hind legs in order to depress the lever situated above its head.

Immediately after being tested for handedness in the Peterson apparatus, 49 rats, 44 of which were left handed, were transferred to the latch box. After being in the situation about a week for 15 minutes or so a day, they had usually learned to depress the shortest lever manually, at which time the testing was begun. Tests consisted of three depressions per day for a week, except where any tendency toward ambidexterity showed, in which cases at least 10 depressions a day were given for longer periods of time. The comparison of the rats' handedness in the two situations is shown in Table 10. We note that 29 rats (27 and 2) showed the same handedness tendency (completely left or right) on both types of apparatus; that 15 (14 and 1) now used the opposite hand; and that *five* were ambi-

TABLE 10

SHOWING THE RELATIONSHIP BETWEEN HANDEDNESS IN THE PETERSON TESTING APPARATUS AND THE LATCH BOX IN A GROUP OF 49 ANIMALS

Latch box	Peterson apparatus			
	Left	Right	Ambi.	Totals
Left	27	1	1	29 (59.2%)
Right	14	2	1	17 (34.7%)
Ambi.	3	0	0	3 (6.1%)
Totals	44 (89.8%)	3 (6.1%)	2 (4.1%)	49

dextrous in one apparatus and preferentially handed in the other. Thus, 20 of the 49 rats were not entirely consistent in the two types of apparatus. The coefficient of mean square contingency (C) applied to these data is .19, and the Chi-square value is .14. On the basis of Fisher's table these low values indicate that the association is probably only a chance one. More specifically, there are 99 chances in 100 that the variations would be as large as these on the basis of chance factors alone.

The three rats listed as ambidextrous in the latch box situation were tested for long periods of time, one for 39 days, another for 40 days, and the third for 51 days. The results are shown in Table 11. Two of the rats, ♂105 and ♀240, eventually became right handed in spite of several days preference for the left hand. Why this should have been true is not clear. The latch box has no feature which would serve to favor either hand. Scattered checks on the Peterson apparatus, as noted in the footnotes to Table 11, indicate that, although both animals had become quite right handed in the latch box situation, they were still completely left handed in the Peterson apparatus. This points to a high degree of independence between the two situations. These results differ from those of Peterson and Fracarol (15), who found ambidexterity to be a consistent characteristic in various food situations. Ambidexterity in the latch box has never been reported before the present study. Peterson (14) found no instance in over 40 cases studied. Peterson concluded that "practice, i.e., chance and previous experience, cannot altogether account for the trait in that ambidextrous animals do not seem to be fixated to an exclusive preference for one hand by a greater amount of practice with that hand." We can agree with him that practice cannot altogether account for the final result, but we did find that

TABLE 11

SHOWING THE PERCENTAGE OF RIGHT REACHES IN THE LATCH BOX BY THREE AMBIDEXTROUS RATS

(At least 10 reaches taken a day)

Days of test	Animal			Days of test	Animal		
	♂105	♀233	♀240		♂105	♀233	♀240
1	0	0	50	28	80	100	90
2	0	0	60	29	90	100	100
3	50	0	50	30	90	100	100
4	71	17	90	31	80	100	100
5	0	90	90	32	100*	100	90
6	7	80	90	33	100	100	20
7	14	80	70	34	100	100	50
8	71	90	100	35	100	100	100
9	43	100	90	36	100	100	100
10	50	100	100	37	70	100	70
11	93	100	80	38	100	100	80
12	70	100	90	39	100	100	50
13	50	100*	100*	40	90	100	
14	40	100	90	41	100		
15	80	100	60	42	100		
16	90	100	90	43	100		
17	90	100	90	44	100		
18	80	100	90	45	100		
19	80	100	100	46	90		
20	70	100	90	47	100		
21	70	100	100	48	70		
22	70	100*	100*	49	70		
23	30	100	100	50	80		
24	80	100	100	51	100		
25	90	100	100				
26	60	100	100				
27	100	100	100				

*On each of these days the latch box testing was supplemented by 25 reaches on the Peterson apparatus. Each of these tests resulted in 25 *left* reaches although the rats had become quite right handed in the latch box tests.

fairly good fixation does take place, even though not always with the hand given the most practice in the earlier training. It should be borne in mind that the two experimental situations were not the same in several respects, the most important of which were specific differences in apparatus and in the previous experience of the animals tested.

G. RESULTS: PART 3

After the 49 rats treated in Part 2 had been separated from the 129 rats which had originally received left training, there remained

80 animals, three from each of the 27 groups of five shown in Table 1. Of this number, 68 were left handed. After the test in the Peterson apparatus which established their left handedness, these 68 rats were placed in the training apparatus which forced *right* reaches. In each group of three rats, one was given one day of right reaches (approximately 300 to 500 reaches), one was given two days (600 to 1000 reaches), and one was given seven days (2100 to 3500 reaches), following which they were retired from forced training for a period of 60 days and then retested. The results in Table 12 show how ineffectual this right training was after left handedness had already been established by previous training. Fifty-two rats out of 68 still retained the use of the left hand in spite of later right practice. Even seven days of right practice against one day of original left practice only succeeded in changing completely one rat out of seven. This is surprising, especially in view of the fact that another rat which changed from left to right handedness with one day's right training, had had seven days of original left training. Such a result makes the acceptance of a mechanical one-to-one agreement between the factors involved impossible, and indicates that we are not dealing with a behavior pattern which is wholly a function of practice.

TABLE 12

SHOWING THE EFFECT OF RIGHT HANDED TRAINING ON 68 RATS THAT PREVIOUSLY WERE LEFT HANDED AFTER LEFT TRAINING

Amount of original left training		Amounts of later right training			
		1 day	2 days	7 days	Totals
	Right	1	0	1	2
1 day	Left	5	6	5	16
	Ambi.	1	0	1	2
	Right	0	0	2	2
2 days	Left	8	6	4	18
	Ambi.	0	2	2	4
	Right	1	1	1	3
7 days	Left	6	7	5	18
	Ambi.	1	0	2	3
	Totals	23	22	23	68

As mentioned above, some workers are convinced of sex differences in handedness. Tsai and Maurer (19) found 59 per cent of their normal male rats to be right handed, 26 per cent left handed, and 15 per cent ambidextrous whereas only 43 per cent of their normal females were right handed, 37 per cent were left handed, and 20 per cent were ambidextrous. They concluded that normal rats are predominantly right handed, but that females show a tendency to left handedness.

Of the 129 rats used in this experiment, 75 were females, 54 were males. After training with the left hand, 65 of the 75 females were left handed (86.7 per cent), and 47 of the 54 males had become left handed (87.2 per cent). These data are shown in Table 13.

TABLE 13

SHOWING THE NUMBER OF RIGHT REACHES OUT OF 175 TAKEN BY 129 RATS AFTER PREVIOUS LEFT HAND TRAINING

	Number of right reaches taken											
	0–15	16–31	32–47	48–63	64–79	80–95	96–111	112–127	128–143	144–159	160–175	Total rats
Males	43	4	0	0	1	0	0	1	0	0	5	54
Females	59	2	4	0	0	0	0	2	0	2	6	75
Totals	102	6	4	0	1	0	0	3	0	2	11	129

The Chi-square technique applied to these distributions gives a P of .70 indicating that there are 70 chances in 100 that the differences are due to chance. Thus we would conclude that a sex difference in handedness, due to practice, is not indicated by our experimental results. Although these data do not directly contravert the conclusion of Tsai and Maurer, further data will be presented in Experiment 2 covering the natural handedness of males and females. These findings fail to corroborate the conclusion of Tsai and Maurer.

Inasmuch as 10 of the 129 rats tested here were congenitally blind in one eye, an opportunity was offered to check the hypothesis that *eyedness either controls or is allied with handedness.* The conditions tested and the results obtained from this group are indicated in Table 14. Only the first four rats (♀22, ♂22, ♂24, ♀37) give an unequivocal test of the hypothesis, inasmuch as the handedness of the other six animals may have been caused by the eyedness, the training, or both. To substantiate the theory, the four rats mentioned first should have been right handed, as they were blind from birth in the left eye. Actually, we see that none of the four are entirely right handed, and that two of them are completely left handed. Considering the last six rats of the table, however, we see that the combination of eyedness and practice (*or possibly practice alone*) seems to control or, at least, to be allied with handedness. An

TABLE 14

CONDITIONS AND RESULTS FOR 10 RATS BLIND IN ONE EYE

Rat	Eye blind	Age at train.	Days L. train.	Days rest	Hded. on Peterson	Hded. on latch box	Days R. train.	Days rest	Retest on Peterson
♀ 22	left	90	7	270	right	left	—	—	—
♂ 22	left	50	7	270	left	left	—	—	—
♂ 24	left	50	2	270	left	*right*	—	—	—
♀ 37	left	50	2	270	left	—	7	60	left
♀ 23	right	90	7	270	left	—	1	60	left
♀ 35	right	50	2	270	left	—	2	60	left
♂206	right	50	1	180	left	—	1	60	left
♂207	right	50	1	180	left	right	—	—	—
♀203	right	50	7	90	left	—	1	60	ambi.
♀ 62	right	25	7	180	left	—	2	60	left

experiment using enough rats to determine whether eyedness increases handedness would be interesting.

A further analysis of Table 10 indicates that eyedness and handedness are not closely related, inasmuch as 15 of the 49 rats tested on both the latch box and Peterson apparatus were using the left hand on one and the right on the other.

The very fact that 102 rats out of 129 (see Table 13) became and *remained extremely left handed after* left *training* indicates that eye dominance, if it is indeed a factor, must be of much less importance than the training factor as here applied.

H. SUMMARY AND CONCLUSIONS

The influence of left-hand practice under various conditions of handedness was measured on 129 rats—off-spring of parents which were all right handed after 14-21 days of practice in a previous experiment. The results support the following conclusions:

1. Left hand training in reaching for food was markedly effective in establishing left handedness, as tested in the Peterson apparatus (Figure 1, *C*). The number of left handed animals was more than double that usually found in an untrained population. Incidence ranged from 81.4 to 90.9 per cent from group to group.

2. The following factors were found to be practically ineffective in determining the influence of training on handedness within the limits investigated: (*a*) amount of practice (1, 2, 7 days), (*b*) age of practice (25, 50, 90 days), and (*c*) length of interval between practice and the test for handedness (90, 180, 270 days). These factors, as varied, did not induce a consistent trend in the handedness index.

3. The influence of training on handedness appears to be fairly specific, within the limits tested. As indicated above, it carried over to the Peterson apparatus, in which the type of reaching is similar to that of the training apparatus (Wentworth). However, only 29 out of 49 tested used the same hand in operating a lever device (Figure 1, *D*) requiring a different pattern of movement.

4. Contrary to the findings of certain other investigators, no significant sex differences in handedness was indicated in our results.

5. Tests on a small number of animals congenitally blind in one eye did not support the commonly held view that eye dominance and

hand preference are closely related. Of four animals congenitally blind in the left eye, none were right handed after left-hand practice as the theory would seem to demand.

6. After handedness has once been established with training it tends to persist even when an attempt has been made to bring about a shift by later right hand practice. Of the group of 68 animals tested, 52 remained left handed (Peterson apparatus) after one, two, or seven days of right hand practice.

IV. EXPERIMENT II

It has been shown, in the preceding experiment, that the tendency to use one hand only in a given food situation could be fixated by as little as one day of forced practice with that hand. This tendency seemed to be relatively permanent and also independent of the age at which practice was given, within the wide limits tested. This fixation seemed to be rather specific, however, since it did not carry over greatly from the Peterson apparatus test to the latch-box test, in which a different hand-movement was required. These general findings suggested that further work of a more analytical nature be done on a number of problems. In the first place, it might well be that even less than one day of forced practice would reverse the natural handedness preference. Moreover, it seemed desirable to quantify the amount of forced practice in terms of the number of reaches, since "one day's reaches" gives only a rough index of practice. It seemed possible also to get closer to the basis of "natural preference" in handedness by reducing the length of the initial test used in the selection of groups for forced practice. It was felt, moreover, that the problem as to the specificity or generality of handedness had not been entirely settled by the work reported in the previous chapter. The present experiment was planned to throw light on these and other questions that we have raised in earlier sections. Since the work on these several problems involved the use of different groups, it will be convenient to describe this experiment under separate headings.

A. APPARATUS

The Wentworth training (Figure 1, *A* and *B*) and the Peterson test apparatus (Figure 1, *C*) have already been described in Experiment I. The reach required by the two types of apparatus is very similar. In the Peterson apparatus, the rat makes an easy forward and slightly downward motion of either arm into the food slot, which is situated immediately in front of the rat's head. In the Wentworth training apparatus, the rat also makes an easy forward and slightly downward motion, but only one or the other hand can be used because of the position of the food slot and dish in the right or left corners of the stalls of both types of training apparatus. The type of reach in the training apparatus differs from that in the

Peterson apparatus only in a very slight lateral displacement of the hand.

The "Circular" apparatus (Figure 2, *A*) was planned somewhat

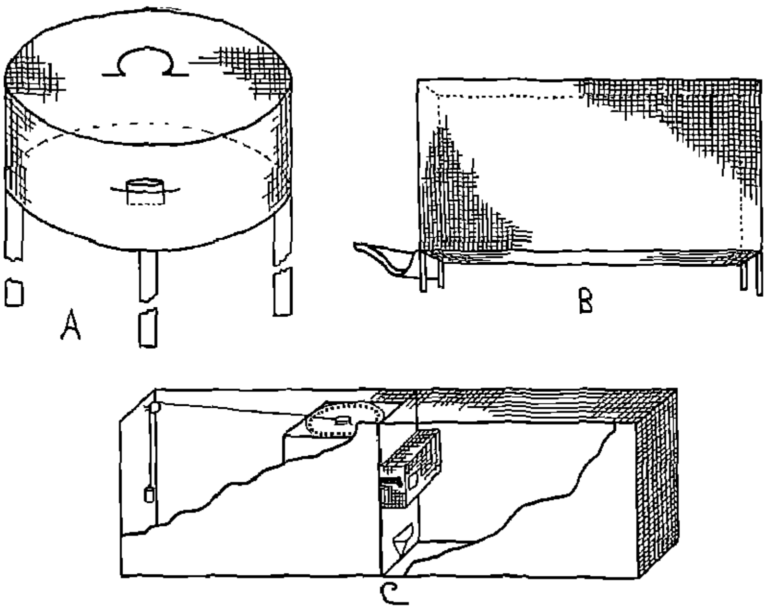

FIGURE 2

TYPES OF HANDEDNESS TESTING APPARATUS

A. Circular Apparatus. *B*. Moat Apparatus. *C*. Modified Skinner box.

after the designs of Yoshioka (23) and Tsai and Maurer (19). It consists of a food cup sunk into the center of a hardware mesh floor. The diameter of the apparatus is about 15 inches with walls also of hardware mesh. The apparatus stood on stilts about six feet high making visibility good both from beneath and from the side. The form of the food cup was changed from the circular shape, used by the above investigators, to a pea-pod shaped device when it was found that the rats failed to reach readily into small circular or square holes. The reach required was a short one and was straight downward.

The Moat apparatus (Figure 2, *B*) consisted of a rectangular wire mesh cage with a half-inch gap in one of the end walls at the point of juncture with the floor. Outside this was a trough or moat nearly two inches wide, on the further side of which is the food. The moat was used rather than a flat platform because it was found (with a preliminary group) that they would scratch or rake in the food rather than make reaches which were definite and easy to count. The reaches in this apparatus were extremely long. Because of the great distance of the food outside the wall of the cage, it was necessary for the rat to turn the face away from the food, place the head and one shoulder to the floor, and stretch the arm through the gap in the wall as far forward as possible. This would seem to be a most difficult kind of reach to make.

The Skinner box (Figure 2, *C*) was modified from that described by Skinner (18) by removing the sound-proof roof and substituting heavy hardware cloth in order to secure visibility. A lever perpendicular to the wall was also attached to the lever-bar running parallel to the wall, the latter being a regular feature of the Skinner box. This secondary lever is first depressed by accident as the rat explores the box. Usually this occurs a few minutes after it has been confined to the apparatus. Pressure on either the secondary lever or the lever-bar sets off a release, a mechanism which allows a small quantity of food to drop into a pan attached to the base of the wall under the lever. After this association or conditioning has been well established, a series of three hardware cloth cages, each progressively less shallow, is introduced by stages over the lever. The third and least shallow cage requires a definite hand reach through a narrow slit in order to depress the lever. This reach requires a forward movement and the rat must stand on its hind legs in front of the lever in order to make it.

B. LENGTH OF THE INITIAL TEST

The aim of the initial test of handedness is merely to classify individuals into three groups for later training: (*a*) the left-handed, (*b*) the right-handed, and (*c*) the ambidexters. It is necessary, of course, that this test be sufficiently long to yield a reliable measure of handedness preference. It is obvious, however, that the longer the test the greater the opportunity for the animal to develop a stereotyped habit of response on the basis of the training involved. Since we wished to cut down the training period in the present experiment it seemed desirable to try to reduce the length of the initial test as well. In Experiment I, this test was based on 25 reaches a day for several days. If we compare the preference shown on the first 25 reaches with that on later tests of 175 reaches we find a remarkable consistency. For example, all of the 91 rats which took at least 24 left hand reaches out of the first 25 reaches remained left handed for the longer test of 175 reaches. Moreover, 8 of the 10 rats that met the same criterion of right-handedness on the first 25 trials remained so through the 175 trial series. This suggests that 25 reaches is enough to establish the initial handedness preference. The evidence here is not conclusive, however, since these animals had had from one to seven days of training before some of the later tests were made.

Further tests were made on a group of 34 rats of the stock used in the psychology laboratory of the University of New Mexico. These animals were given 25 reaches in the Peterson apparatus (Figure 1, *C*). The results of the test, in terms of *right* reaches are shown in Table 15. From this group, 24 rats were selected with an initial preference score of at least 24 *left* or *right* reaches out of 25. These were given "one day" of forced training with the non-preferred hand in the apparatus shown in Figure 1, *A* and *B*, and then kept in the living cages with no further training for 60 days. As shown in Table 16, less than half of the animals had shifted their preference on the later retest. It seems, therefore, that one day's training in this case was not enough to balance out the "natural" preference, in most cases at least. These results may seem to disagree with those reported in Table 4 on a group of the same age. There it was found that one day's training caused a shift of 71 per cent in handedness, whereas the shift here is only 41.7 per cent. However, the latter group had at least 24 reaches with the preferred (natural) hand before the training was begun, in connection with the initial test. Apparently then, the reaches made during the initial test (24 or 25 here) may influence considerably the fixation of handedness. In short, an initial test as long as this appears to involve sufficient training to determine in part the shifting of handedness after forced training. This factor would likely be most effective in the case of ambidexters. In the light of these findings, it seemed desirable to see whether the initial test could not be reduced below the 25 reach

TABLE 15

Showing the Number of Right Reaches Out of 25 Taken by 34 Untrained Rats on the Peterson Apparatus

	Number of right reaches																									Total
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
No. rats	7	3*	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	2	1	1	4	11	34

*One of these three rats was given *left* training later by error and was discarded.

TABLE 16

Showing the Handedness of Rats on the Peterson Apparatus after One Day of Training with the Non-Preferred Hand

		Number of right reaches out of 175—second test											Totals
		0–15	16–31	32–47	48–63	64–79	80–95	96–111	112–127	128–143	144–159	160–175	
No. right reaches out of 25—first test	24–25	4	0	0	0	0	0	1	0	0	1	9	15
	2–23					Discarded as ambidexters							
	0–1	2	0	0	0	0	0	0	0	1	1	5	9
	Totals	6	0	0	0	0	0	1	0	1	2	14	24*

*According to our criterion, 10 animals have shifted to the opposite hand, two have become ambidextrous, and the remaining 12 have been unaffected by the training.

level and still give a reliable index of natural preference. In view of the stability of the preference, it appeared likely that such an index could be based upon a much lesser number of reaches.

It was decided to see whether or not 10 reaches in the initial test would be sufficient. A group of 105 rats, 25 days of age, were tested on the Peterson apparatus (Figure 1, *C*). Of this group, 74 made at least 9 out of 10 reaches with one or the other hand, 31 showed a less definite preference (Table 17). The animals were divided into two groups as follows. Control group—18 rats scoring either 9 or 10 reaches with one hand and 31 rats showing a less stable preference (since these could not be used in the training series). Experimental group—56 rats scoring either 9 or 10 reaches with the same hand.

TABLE 17

SHOWING THE CLASSIFICATION OF 105 UNTRAINED RATS, 25 DAYS OF AGE, ON THE BASIS OF A 10-REACH CRITERION

Groups	Number of animals 9-10 reaches	2-8 reaches	Total
Control	18	31	49
Experimental	56	0	56
	74	31	105

The animals placed in Column 2 are regarded as handed since they made either 9 or 10 reaches with the same hand. Those less stable are placed in Column 3.

Our interest at this point is in the control group only. After the 10-reach test, these animals were placed in the usual living cages and allowed to live under normal conditions for 60 days without training. They were then re-tested in the Peterson apparatus and in three other types of apparatus which will be described below. The results gained in the Peterson tests are indicated in Table 18. As we are concerned here with the reliability of the 10-reach test, Table 18 will be analyzed at this point only with respect to this matter. Of the 18 rats that had shown a definite handedness in the initial test, 13, or 72.2 per cent still used the same hand, while five had become ambidextrous. The greater shifting of the ambidextrous group is of no real importance here, since only animals with definite handedness are commonly used in forced training studies. It seems, therefore, that a 10-reach initial test offers a dependable basis for segregating animals into right and left handed groups, provided a high criterion of handedness is employed as in the present study.

TABLE 18

SHOWING THE HANDEDNESS OF CONTROL AND EXPERIMENTAL GROUPS IN AN INITIAL TEST OF 10 REACHES AND A FINAL TEST OF 15 REACHES *IN THE PETERSON APPARATUS*

	Control group				Experimental group*			
	Initial test	Final test			Initial test	Final test		
		Right	Left	Ambi.		Right	Left	Ambi.
Right	9	6	0	3	24	4	13	7
Left	9	0	7	2	32	10	11	11
Ambi.	31	10	8	13				
	49	16	15	18	56	14	24	18

*The animals of the experimental group were given 200 reaches with the non-preferred hand between the initial and final test. Only definitely handed rats in the initial test were placed in the experimental group.

In view of these results, it was decided to use a 10-reach initial test in the several later phases of Experiment II.

C. INFLUENCE OF 200 REACHES ON HANDEDNESS

As was shown by the results of the preceding experiment, forced practice for a period of as little as 24 hours was remarkably effective in fixating handedness to the practiced hand. Milisen (9) estimated that in such a full day of practice, rats ordinarily reach between 300 to 500 times. In view of the above it was decided to restrict the forced practice in the present experiment to 200 reaches, actually counted, with the hand opposite the preference expressed by the 10-reach initial test. Thus, we are able to ascertain whether this smaller amount of practice is effective in fixating handedness. Also we have here a more quantitatively exact basis of the amount of practice.

The experimental group of 56 rats 25 days old, all markedly left or right handed (at least 9 out of 10 reaches) were given 200 forced reaches in the Wentworth training apparatus (Figure 1, *A* or *B*) with the hand opposite to that preferred in the initial 10-reach test. They were then placed in the living cages for 60 days, at which time the final tests for handedness were begun.

The results of this procedure are shown in Table 18. As will be seen, the 200 reaches of forced training proved to be sufficient to reverse the initial preference in the case of many of the animals. In the initial test, each of the 56 animals had shown a definite right or left preference in at least 9 of the 10 trials given. When tested 60 days later in the same apparatus, only 15 of the 56 animals (26.8

per cent) retained this original preference. On the other hand, 13 of the 18 handed animals of the control group (72.2 per cent) still retained their initial preference after an interval of 60 days without forced training. A comparison of these data would seem to indicate that the forced training had induced a shift in handedness in nearly half (the difference between 26.8 and 72.2 per cent or 45.4 per cent) of the animals of the experimental group. It is thus apparent that 200 reaches of forced training are enough to break up the initial hand preference when the animals are retested in the same apparatus (Peterson test). In 23 animals (41.1 per cent) this training led to a reversal of the initial preference; in 18 animals (32.1 per cent) it led to the development of ambidexterity in terms of our criterion —using the same hand in less than 12 out of the 15 trials given in the later test.

It is interesting to note that very similar results obtained even when these animals were tested on the three other types of apparatus as well. This will be indicated by a comparison of the control and experimental groups as shown in Tables 19 and 20. On the Moat test, 11 of the 18 handed animals of the control group retained the original preference after 60 days, while this was true of only 22 of the 56 animals of the experimental group. Thus the forced training would seem to account for the 21.8 per cent greater loss of the initial preference shown by the experimental group. The corresponding figure for the Circular apparatus is 47.4 per cent and that for the Skinner box is 17.6 per cent. Since the experimental group had never been tested or trained in the three tests under consideration, the carry-over effect of the forced training might well be expected to be less than in the Peterson apparatus, where the corresponding value is 45.4 per cent.

D. Is Handedness Specific or General?

The question here is as to whether a hand preference expressed naturally or after establishment by forced training on one type of apparatus will carry over to feeding situations in other kinds of apparatus. As will be recalled, one part of Experiment I related to this problem in a limited way. It was found there that such a *preference did not carry over to the latch box test from the Peterson* apparatus. The present aim was to make a more extensive analysis

TABLE 19

Showing the Handedness of 18 Extremely Handed Rats (Control Group) on an Initial Test in the Peterson Apparatus and on a Final Test in Four Situations

Rat number	Initial test Peterson apparatus	Final tests Peterson	Circular	Moat	Skinner	Summary Same	Shift	Reverse
1	R	R	R	R	L	3		1
2	R	A	R	R	R	3	1	
3	R	R	R	R	A	3	1	
4	L	L	L	R	A	2	1	1
5	L	A	A	R	A		3	1
6	L	L	L	L	L	4		
7	R	A	A	L	A		3	1
8	R	R	R	R	R	4		
9	L	L	L	L	L	4		
10	L	L	L	A	L	3	1	
11	R	R	R	R	A	3	1	
12	L	A	A	L	A	1	3	
13	L	L	L	R	R	2		2
14	L	L	L	L	A	3	1	
15	L	L	L	L	L	4		
16	R	R	R	R	A	3	1	
17	R	R	R	A	R	3	1	
18	R	A	L	L	R	1	1	2
Summary	Same	13	14	11	8	46		
	Shift	5	3	2	8		18	
	Reversal	0	1	5	2			8

TABLE 20

SHOWING THE HANDEDNESS OF 56 EXTREMELY HANDED RATS (EXPERIMENTAL GROUP) ON AN INITIAL TEST IN THE PETERSON APPARATUS AND ON A FINAL TEST IN FOUR SITUATIONS AFTER AN INTERPOSED SERIES OF 200 REACHES WITH THE HAND OPPOSITE THAT USED IN THE INITIAL TEST

	Initial test	Final tests				Summary		
Rat number	Peterson apparatus	Peterson	Circular	Moat	Skinner	Same	Shift	Reversal
1	R	R	R	R	R	4		
2	L	L	A	R	L	2	1	1
3	R	A	L	L	A		2	2
4	R	R	R	R	R	4		
5	R	L	L	L	A		1	3
6	R	L	R	R	L	2		2
7	R	L	L	L	A		1	3
8	L	A	A	L	R	1	2	1
9	L	L	L	L	R	3		1
10	R	L	L	A	A		2	2
11	R	L	L	L	L			4
12	L	L	L	R	A	2	1	1
13	L	A	R	R	L	1	1	2
14	R	L	L	A	A		2	2
15	R	R	A	L	L	1	1	2
16	R	A	R	R	A	2	2	
17	R	A	A	R	L	1	2	1
18	L	R	R	R	R			4
19	R	A	A	L	A		3	1
20	L	R	R	R	A		1	3
21	L	A	A	R	L	1	2	1
22	L	A	R	R	L	1	1	2
23	L	R	A	R	A		2	2
24	R	L	L	A	L		1	3
25	L	R	R	R	A		1	3
26	R	L	L	R	R	2		2
27	L	A	A	R	R		2	2
28	L	L	L	L	L	4		

TABLE 20 (*continued*)

Rat number	Initial test Peterson apparatus	Final tests Peterson	*Circular*	Moat	Skinner	Summary Same	Shift	Reversal
29	L	L	L	R	L	3		1
30	L	L	L	R	L	3		1
31	R	L	L	L	L			4
32	L	A	L	A	L	2	2	
33	R	A	L	R	L	1	1	2
34	L	A	L	R	A	1	2	1
35	R	A	A	R	L	1	2	1
36	L	L	A	R	R	1	1	2
37	R	L	L	R	L	1		3
38	L	A	R	R	A		2	2
39	L	A	R	L	L	2	1	1
40	L	A	L	L	A	2	2	
41	L	R	R	A	A		2	2
42	R	L	L	L	R	1		3
43	L	R	R	R	A		1	3
44	L	R	R	R	R			4
45	R	A	L	L	L		1	3
46	L	A	A	L	R	1	2	1
47	L	L	L	L	A	3	1	
48	R	R	R	R	A	3	1	
49	R	L	L	L	A		1	3
50	L	L	L	L	L	4		
51	L	R	L	A	L	2	1	1
52	L	R	A	L	A	1	2	1
53	L	L	A	L	A	2	2	
54	L	L	L	L	A	3	1	
55	R	L	L	L	L			4
56	L	R	A	L	A	1	2	1
Summary	Same	15	17	22	15	69		
	Shift	18	14	6	23		61	
	Reversal	23	25	28	18			94

of this factor by utilizing a number of test apparatus representing different degrees of divergence from the standard training situation.

The subjects in this portion of the study were the 105 offspring of 16 females secured from a Brooklyn, New York, commercial dealer. They were born in the Columbia animal laboratory and raised under standard conditions. The animals were all tested first in the Peterson apparatus, in which the act required is to secure powdered food (Growena) by reaching and feeding movements. The same food was used in all the later tests except in the Moat apparatus (Figure 2, *B*) and in the Skinner box (Figure 2, *C*). In the Moat apparatus, the hands are likely to be in a position where it is difficult to carry powdered food to the mouth. Small sticky pellets, made of a mixture of corn meal, Growena, and cod-liver oil were utilized in this apparatus. A mixture of corn meal and Cream of Wheat was substituted for the Growena in the Skinner box because the Growena tended to pack instead of running smoothly down the shute.

As indicated above in Section *B*, the initial test consisted of 10 reaches each in the Peterson apparatus by 105 rats 25 days of age. The distribution of the animals into control and experimental groups has already been indicated in Table 17. Forty-nine of them were returned to the living-cages until they were 85 days old (60 days after the initial test), at which time the final tests were begun. These tests consisted of five reaches in one apparatus, followed on the second day by five more reaches in a second apparatus, and so on until 15 reaches had been taken in each of the four types of apparatus. This rotating schedule was adopted in order to eliminate as far as possible the practice factor in the test situation. The remaining 56 rats were treated in an identical manner except that they were subjected to 200 reaches in the Wentworth apparatus with the hand opposite their preference immediately following the initial test in the Peterson apparatus. The training apparatus used here is the same as that designed by the writer for previous experiments, and is shown in Figure 1, *A* and *B*. The type of reach here required is very similar to that in the Peterson apparatus. The distance and direction are identical, except that in the latter the animals are stationed directly in front of the food dishes, whereas in the former their stance is slightly to the right or left of the food dish depending on which hand is to be used in the training procedure.

The criteria of handedness used here were as follows: at least 9 out of 10 reaches in the original test had to be with one hand; at least 12 out of the 15 reaches in each apparatus during the later tests had to be with one hand. The stricter criterion (9 out of 10) was demanded here to insure that we had definite handedness in the initial short test. The more lenient criterion (12 out of 15 reaches) agrees more nearly with the 75 per cent criterion used by other experimenters.

In this section we will consider the generality of original handedness preference and the generality of handedness imposed by forced training. This latter might be considered as the generality of training. These two aspects of the problem will be taken up in the order stated above.

1. *Original Preference*

The 49 rats previously described as "control" animals, shown in Table 18, and especially the 18 rats originally either right or left handed comprise the group which throws light on the generality of original preference. Because of the extreme instability of handedness found among ambidexters, when the retest was made in the same apparatus, we shall consider the 18 handed rats more carefully than the ambidextrous.

The handedness of these 18 extremely handed rats in the different situations is shown in Table 19 and reveals much specificity of handedness. The summary at the extreme right indicates the trends through the series for each of the rats while the summary at the bottom of the table shows the trends through the types of apparatus. The summary at the right reveals that only 4 of the 18 rats maintained their original handedness on all four types of apparatus,[4] although 8 others remained like handed in 3 of the 4 situations. The remaining 6 rats show differing degrees of unlike handedness in the four later test situations.

The summary at the bottom of Table 19 shows the greatest amount of like handedness between the original Peterson test and the later

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[4] The mothers of the 105 rats being used in this experiment were also tested. This was done to perfect the technique to be used on the offspring and to supply data concerning hereditary influence. As with the 18 control animals, only 4 of the 14 mothers tested were found to be using the same hand in all four types of apparatus.

Peterson and Circular tests. Less agreement is found between the original test and the Moat and Skinner tests.

Analysis of the body of Table 19 reveals that there is greatest agreement in handedness among the final tests between the Circular and later Peterson tests, with 16 of the 18 rats showing the same preference and none reversing handedness. The greatest amount of disagreement is between the Moat and Skinner tests, with only 6 of the 18 having the same handedness and 12 showing some degree of difference.

The degree of change in handedness roughly follows a common sense order of the similarity of movement involved in reaching. As we saw above, the greatest degree of agreement was between the Peterson and Circular tests. The movements required in each are very similar. The Peterson apparatus (Figure 1, *C*) which had already been described, allowed an easy and short, forward-downward reach of the hand. The "Circular" apparatus (Figure 2, *A*) required a short reach, straight downward under the animal's body into the dish below. The stance was essentially the same as in the Peterson apparatus, but the position of the food was under the body rather than in front.

Very little agreement in handedness was found between the initial Peterson test and the later test on the Skinner box and only slightly more between the initial test and that in the Moat apparatus. Furthermore we noted that there was extremely little agreement in the handedness in the Skinner box and the Moat apparatus. These facts would indicate that there is little similarity of movement among these three types of apparatus, which indication is borne out by a study of them. The Moat apparatus (Figure 2, *B*) required a long, forward reach. To get food the rat must place the head and one shoulder to the floor, stretch the arm directly forward as far as possible, and extend it through the hole in the base of the wall. The reach required in the modified Skinner box (Figure 2, *C*) was forward and upward, with the animal standing on its hind legs in front of the secondary lever. The stance differed from that in the other types of apparatus and the hand movement was upward rather than downward and forward. Also this Skinner box involved reaching for and depressing a lever whereas each of the other situations required merely the grasping of food.

The 31 rats originally ambidextrous in the Peterson apparatus exhibited much instability of handedness (Table 18). Even on the retest (60 days later) in the Peterson apparatus 18 of the 31 animals were found to have shifted to the consistent use of one hand. This phenomenon was noted with 28 rats in the Moat apparatus, 20 in the Circular apparatus, and 21 in the Skinner box. Of these 31 rats originally ambidextrous none remained ambidextrous in all of the later tests, although nine had become consistently handed in all four tests. The data on four of these nine rats are unusual enough to be described here. One rat was a perfect ambidexter on the basis of the original test of 10 reaches, taking five right and five left reaches, but in the final tests it took all 60 reaches with its right hand. A second rat was ambidextrous (6 left reaches out of 10) but also later took all 60 reaches with its right hand. Two other rats gave identical data. Each took 8 left reaches out of 10 in the initial test, thus missing being considered left handed by only one reach, yet in the final tests they were right handed in each apparatus and took a total of 52 right reaches out of 60.

2. *Preference After Training*

As noted in Section C, when rats are subjected to handedness training of as little as 200 reaches opposite to their natural preference a shift occurred in the handedness preference of many of the animals. The generality or specificity of this forced handedness will now be considered. In Table 20 is shown the handedness of each of the 56 rats in all five situations.

The summary at the right of the table shows that four of the 56 rats (7.1 per cent) still retained their original preference in all the later tests (this compares with four of the 18 control rats, or 22.2 per cent, which did not receive opposite hand training). On the other hand, we see that 5 of these 56 rats, or 8.9 per cent, consistently reversed their handedness to agree with the hand used in the forced training. None of the 18 rats which received no forced training showed a consistent reversal of handedness later.

Totals of the summary columns indicate that the same hand as originally preferred was used in 69 tests, whereas the trained hand was used in 94 situations. This indicates that the effect of the amount of training given here was more potent than that of original preference as revealed in the Peterson apparatus.

The summary at the base of the table shows that in each apparatus more rats have handedness which agrees with the forced training than with the originally preferred hand.

Analysis of the body of Table 20 reveals that here as in the control group (Table 19) the greatest agreement in handedness among the final tests is between the Circular and Peterson tests, with 36 of the 56 rats agreeing exactly and only two being opposite handed. Also here again, the greatest disagreement is between the Moat and Skinner tests, with 18 of the 56 having the same handedness and 38 showing some degree of difference. Thus the data on both the control and trained groups show that consistency in the use of the same hand in a variety of situations depends upon the degree of similarity of the reaching reactions involved.

It is rather clear from this general analysis that handedness—either natural or trained in—is fairly specific in the white rat. Preferences do not carry over even to other feeding situations if these impose markedly different movement patterns. It seemed unnecessary, therefore, to extend the scope of the tests to include nonfeeding situations.

E. SEX DIFFERENCES IN HANDEDNESS

In Experiment I, we found no sex differences in handedness when due to practice. In the present experiment, we have tested rats for handedness without the pre-training program. These rats, 105 in all, are grouped according to sex and handedness in Table 21. When the Chi-square technique is applied to these data, a P between 10 and 20 per cent is obtained. This indicates that the relationship found here would be equalled or exceeded between 10 and 20 per cent of the time with two samples both of males and females. This lends itself to the conclusion that a sex difference in handedness is

TABLE 21
HANDEDNESS OF 105 RATS, UNINFLUENCED BY TRAINING, AS INDICATED IN A 10-REACH TEST IN THE PETERSON APPARATUS

	Males	Females	Totals
Right	14	19	33
Left	23	18	41
Ambi.	21	10	31
Totals	58	47	105

not demonstrated, insofar as the type of reach utilized in the Peterson apparatus is concerned.

F. Summary and Conclusions

The results secured in the present experiment would appear to support the following conclusions:

1. It was found that as few as 10 reaches are sufficient to determine the original preference in the Peterson apparatus. The use of such a short initial test for classifying rats as to natural handedness preference has the advantage of reducing to a minimum the possible practice factor arising from the test.

2. As few as 200 forced reaches against the natural preference were sufficient to cause a shift in handedness in many animals, when tested after a 60 day period of living in cages under normal conditions. Of the 56 rats in this group, 23 showed a shift to the opposite hand, 18 shifted to ambidexterity, and 15 retained the same preference as before. The degree of shift was much greater than in the control group which was given no training—13 of the 18 control rats retaining their original handedness and none reversing entirely.

3. It was found that there were varying degrees of persistence of the natural handedness preference to other test situations involving the feeding response. The amount of carry-over decreased roughly as the similarity between the test situations decreased—the reaches required in the Peterson and Circular tests being quite similar, while those in the Moat and Skinner box test were dissimilar to each other and to those required in the first two types of apparatus. In general, the results indicate that handedness is fairly specific to the type of reach involved.

4. There were also varying degrees of carry-over of the hand preference induced by forced training to other feeding situations. The amount of carry-over seemed to depend on the similarity factor and the order from test to test followed that shown above for natural preference.

5. No significant sex difference in natural handedness was found.

V. GENERAL DISCUSSION OF RESULTS

Since the animals vary in handedness from one test to another, no single test can be used to indicate an animal's natural handedness. Both experiments are concerned with the development of specific habits (right or left) and with the question of amount of transfer from one test to another, rather than with any change in general handedness.

In Experiment I it was found that training in the Wentworth apparatus tended to carry over to the very similar Peterson apparatus, since many animals used the same hand in the latter as in the former. However, once the specific reaction to the Peterson apparatus is thus established, this is not disturbed by training the other hand in the Wentworth apparatus. The first training in the Wentworth apparatus tended to make the rat use the trained hand in the Peterson apparatus (no previous contact) and to much lesser degree in the latch box. Once these were known and definite modes of behavior established with reference to them, that behavior was not broken down by new and different training in the Wentworth apparatus.

Experiment II indicates a certain amount of generalization of handedness, whether natural or the result of training. This persistence of handedness seemed to correspond fairly well with similarity between the initial test response and those required later and also between the similarity in the trained movement and those occurring later.

Perhaps a word should be said regarding the relationships of our results to those of other workers. A review of previous work has been given in the introductory chapter, hence only a brief statement is here necessary. Our results disagree with those of Milisen, who reported that native sidedness was more important than training, that males and older rats of both sexes were less readily influenced by training. Tsai and Maurer had also reported a sex difference. In general, our results agree with the views of Peterson that heredity is not the dominant factor in sidedness, and that there is little consistency in handedness from one test situation to another.

VI. GENERAL SUMMARY

The aim of this study was to determine the possible influence of practice and various other factors on handedness in the white rat. The findings seem to support the following conclusions:

1. The incidence of left handedness rose from the normal level of about 42 per cent to approximately double this amount as a result of left-hand training in the offspring of parents in which right handedness had been induced by training.

2. Although forced training under all conditions was very effective, no significant differences in the degree of effect was found among groups representing the following factors: (*a*) age at which training was given (25-90 days), (*b*) amount of training (1-7 days of practice), and (*c*) interval between training and testing (90-270 days).

3. No indication of a sex difference in handedness was found.

4. No significant relationship was found between handedness and eyedness in the case of a number of animals that were congenitally blind in one eye.

5. It was found that once a preference was induced by training, it was little influenced by forced training of the opposite hand but remained stable for periods up to 270 days or longer.

6. The fact was demonstrated that a reliable measure of natural handedness preference could be established by a 10-reach test.

7. As little as 200 forced reaches was found to be sufficient to bring about a shift in preference in nearly half of the subjects tested.

8. The initial or natural preference proved to be fairly specific as determined by tests on various types of apparatus in which reaching for food was required. In general, the persistence of handedness in such test situations seemed to correlate roughly with the degree of similarity between the initial test response and that required in the several types of test apparatus utilized later.

9. The influence of forced training on handedness was found to be fairly specific as measured by the degree of handedness shown in tests on various types of apparatus involving a feeding response. The amount of carry-over here seemed to correlate roughly with the similarity between the trained-in movement and that involved in the later test situations.

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By Else Frenkel-Brunswik

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MOTIVATION AND BEHAVIOR*

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	Acknowledgments	123
I.	Introduction	125
II.	Procedure	141
III.	Distributions and reliabilities of drive ratings	149
IV.	Influence of judges' personalities on drive ratings	155
V.	Interrelationships between ratings on drives	171
VI.	Relationship of rated drives to behavior in social situations	179
VII.	Drive patterns and behavior patterns	199
VIII.	Drives and general traits	225
IX.	The meaning of the adjustment inventory (self-reports) in terms of ratings of situational behavior, drives, and traits	241
X.	Rated drives compared with further independent data	253
XI.	Conclusion	261
	References	265

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I. INTRODUCTION

A. THE USE OF MOTIVATION CATEGORIES IN PERSONALITY RESEARCH

Interest in motivation is as old as psychology, but approaches to this problem have, in the past, been to a large extent speculative and introspective. Behaviorism in its earlier forms was not particularly open to questions of motivation, emphasizing overt responses to immediate stimuli rather than internal dynamics of personality. Normative psychology developed methods for studying some aspects of motivation experimentally from about 1920, concentrating on such topics as the strengths of single "drives" in animals and upon some formal aspects of human motivation, e.g., level of aspiration. The dynamics of human behavior in its full context and complexity, including the pattern and inter-relatedness of the various motivating forces have, however, remained comparatively neglected by the methodologically conscious academic psychologist. Though there may have been agreement about the importance of this topic,[1] the field was left to a large extent to loosely validated clinical and psychoanalytical approaches.

The reason for this lies primarily in the difficulty of objectifying the tangled relationship between action and the patterns of underlying dynamics. By this very difficulty, research was greatly hampered. The terms motivation and behavior refer to different levels of the personality which are not equally accessible. Behavior can be observed directly; motivation is inferred and has the character of an explanatory construct.

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[1] There is in the psychological literature an increasing recognition of the fact that a full comprehension of personality must include reference to motivational categories. Lewin systematically advocates the importance of a dynamic psychology. Murray uses chiefly motivational categories as personality variables. In textbooks of personality such as those by Allport, Murphy and Stagner, discussion of dynamics occupies an increasing amount of space. "If there is any one fundamental trend during the last few years which is of basic importance in the study of social behavior, it is the emphasis upon relations between social behavior and personality organization of the individual child. Both the confusion arising from statistical analysis of data which ignore personality structure and the coherence which we find when the social behavior of an individual is seen in relation to such structure, make this apparent. We see this in connection with studies of aggression, competition, leadership, sympathy; there is probably no aspect of social behavior which can be adequately understood apart from its relation to the personality of the individual" (14, p. 279).

There have been two major types of inadequacy in approaching the problem of the relationships between motivation and behavior. First, some investigators worked on the basis of a tacit assumption of a perfect one-to-one correspondence between motivation and action. The concept of motivation thus is rendered merely a descriptive one, in fact nothing but an internalized, unnecessary duplication of behavior rather than a truly explanatory, dynamic one with some degree of independent approach (4). It is nothing short of some kind and some degree of independent variability which would really necessitate the introduction of motivation as a separate category to account for the various patterns of manifestations. The very complexity of the relationship between behavior and motivation makes definition and measurement of the latter—separate from and independent of specific behavior—as difficult as it is.

Second, clinical psychology being in need of dynamic concepts which would possess real explanatory value, introduced concepts too remote from behavior and often not verifiable.

In the present study, an attempt was made to reduce, at least partially, these fundamental difficulties by using comprehensive and complex dynamic concepts and providing operational specification for them. In particular, ratings of "drives" were used and an effort was made to specify their meanings by statistical analyses of their relationships to concrete behavior data and other reactions.

The shift of emphasis from the level of external overt manifestation to the level of motivational dynamics became necessary in order to find a common frame of reference for various aspects of personality such as those collected in the California Adolescent Growth Study (8, 9).

Reference to motivation was found to be of real help in organizing and understanding personality data. Furthermore, motivational categories were discovered to be of value in predicting reactions on tests which were not used in making the drive ratings.

B. Relative Independence of Manifest and Motivational Personality

The manifest or surface personality is defined by the directly observable gross features of behavior when taken at their face value, and when the broader context, i.e., the background as well as the consequences of behavior, which point beyond the situation, is not taken into consideration.

The distinction between manifest and inferred motivational personality seems to be especially important in our culture. Quite often, real motivations cannot be shown openly. Nevertheless, as a rule they do not cease to exist and to exert influence.

A good example of the discrepancy between surface behavior and motivation can be given by referring to one of the members of the adolescent group studied. Let us call him John. According to the observational ratings, he is below average in openly displayed aggressive behavior; yet all the observers thought of John as fundamentally a highly aggressive person. When the subjects were rated on their motivational patterns (see below), John received a high rating on the "Drive for Aggression," obviously on the basis of indirect indications.

Common observation points in the same direction. It is well known that exaggerated friendliness may serve, or even be the direct *result of, strong destructive tendencies. Conversely to the case of* John, noisy aggression may go with a character which is soft and fundamentally good-natured.

Instances of such discrepancies are indeed numerous. They are not limited to items such as aggressiveness. To come back to the example of John, he was rated low on most of the social behavior items indicating actual social participation, yet was considered by the same observers to be highly motivated by a desire for the establishment of social ties.

It may thus be said that overt behavior and the underlying motivational tendencies may vary independently in a statistical sense, although in a broader sense motivation is conceived as determining all behavior. An intense striving may find not more than very subtle and inconspicuous behavioral manifestations. On the other hand, the most conspicuous behavioral features may in certain in*stances have little dynamic significance or lasting effect.*

A conceptual distinction comparable to the one suggested here is that used by biologists when they differentiate between phenotype, or face value description on the one hand, and genotype, or underlying causal structure, on the other. This distinction is necessitated by the facts that one and the same phenomenon may have different kinds of "causes," and one and the same "cause" may lead to a diversity of phenomena, depending on other conditions. A statement about a phenotype (e.g., a behavioral technique) does not permit unequivocal conclusions about the genotype (e.g., motivation), and vice versa (13).

We have already indicated that motivational tendencies are ultimately "behavioral" if this term is taken in a wider sense, and that the concept of drive is here conceived in an entirely operational fashion, in that the verification of a statement about the presence or absence of a certain drive would always have to be based on behavior observations. But if specific observable behaviors are, as we have seen, apparently "independent" of underlying drives, how can we make such verifications? The answer is that our knowledge of motivation is established as the result of a complex process of reconstruction or inference, utilizing the most minute cues as well as gross features of behavior. Sometimes minimal cues which could easily be omitted from a description of overt behavior may even be given more weight than the conspicuous behavioral features. It will always be some form of behavior, however, by which the aggressive person, using the technique of friendliness, will under certain conditions reveal his aggressive motivation.

In a complete description of personality, both aspects, the manifest as well as the motivational, must necessarily be included. In a certain sense, motivation is more important than manifestation since it will determine the course of behavior in the long run and thus furnish better possibilities for explanation and prediction. On the other hand, the ways in which motives are manifested are of utmost importance in diagnosing the interrelatedness of the various motivational tendencies. Only by learning about the relationships of the two aspects in all their complexity can we hope to use behavior as an accurate diagnostic symptom. John would be a different person had he openly displayed rather than repressed his aggressiveness, and he would also be different if his lack of overt aggressiveness reflected a lack of covert aggressive tendencies.

The drives are here not conceived as faculty-like substantive units or vital agents. Neither are they to be considered as rigid and permanent factors in personality such as McDougall's instincts. The concept of drive implies a type of construct which may most economically and fruitfully integrate behavior data so that patterns of cause and effect may be recognized within the personality. Furthermore, in many instances a motivational tendency will be found to be flexible and shifting though it is more stable than behavior incidental to transient situations.

For a wide variety of problems we need not be concerned about the degree to which a certain motivational tendency may be innate or acquired in an earlier or later stage of life. Thus even what the psychoanalysts call "reaction formation"[2] will be treated in the same way as any of the more fundamental dynamic tendencies.

Generally, psychoanalytic terms refer to "deeper motivating" levels of personality than those represented in our material. Part of this difference is due to the fact that drive ratings were in our case introduced primarily as a help in organizing self-reports and behavioral data. Individual differences regarding these forms of expression can probably not be adequately analyzed in terms of motivation levels as remote as those considered by psychoanalysis, without having previously ascertained the rules by which these levels are tied to levels closer to behavior. The concept of drive, as we are using it, stands somewhere in between overt behavior and the explanatory level which psychoanalysis attempts to reach.

C. Alternative Manifestations of Motivational Tendencies

Aside from the statistical independence of the manifest and the motivational aspect, there may be another feature which could render a reference to the pattern of drives which underlie overt behavior very desirable from a research point of view. Drives may be conceived as comparable to the few factors found by factor analysis to account for many *apparently diverse* abilities. That is, a comparatively small number of drives *in a particular combination* may account for a wide array of behavioral *manifestations.* Each drive would then be linked to several such manifestations. Furthermore, the manifestations might be different from time to time, or from individual to individual, within the total range of possibilities of manifestations, in accordance with the rest of the internal or external conditions co-determining behavior. In other words, there may be alternative manifestations.[3] Common observation, and scattered information and theory in psychology and psychoanalysis, tell us that a certain striving may find either this or that manifestation, or both of them.[4] More often drives are associated with several possibilities of expression. To anticipate one of our findings, a strong drive for Aggression or Recognition would manifest itself, depending on inner or outer circumstances, either in overt and successful social activities or in tenseness. Dynamic concepts, as Lewin points out, "circumscribe a whole range of possibilities of manifestations" (12). To come back to a previous example, aggressive behavior as well as overtly friendly behavior may serve destructive tendencies. The determination of the specific manifestation of a drive probably depends on the particular pattern of drives together with environmental factors.

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[2] Under reaction formation we understand a permanent alteration of behavior as *protection against anxiety or conflict (5).*

On the other hand, it will also be shown that one and the same manifestation may be related to different drives; in other words, that it may have different dynamic significances. By means of a network of correlations—straight, partial, and multiple—the relationships between assumed underlying dynamics and manifestations will be analyzed (Chapter VII), showing in detail "that a complex society permits varying significance to be attached to similar behaviors and similar significance to diverse behaviors" (14, p. 270).

As a result of the reorganization of the behavior data in terms of underlying dynamics, apparent inconsistencies of behavior may be reconciled. To quote Allport:

> A deeper consistency may often underlie superficially discordant activities. . . . (A) root quality may "explain" the inconsistency in one's expressive traits, (and) at the same time explain

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[3] The author has become especially aware of the principle of alternative manifestation of underlying motives, in connection with psychoanalysis (see Frenkel-Brunswik, E., l. c.). As pointed out by Egon Brunswik, ("*The Formal Structure of Psychology*," Encycl. of Unified Science, vol. II in prep.) the major objective criteria for units of action in psychology, such as those of Tolman, Hunter, Hull, and others are explicitly or implicitly based on a recognition of "vicarious functioning" of perceptual cues or behavioral means relative to some focal variables.

[4] Another aspect of alternative manifestation is suggested by H. E. Jones: "One child may contribute marked galvanic reactions for a certain intense stimulus; another may show marked overt responses; and still another may react in both spheres of expression" (7).

> almost everything else in his nature, serving to reconcile other apparently discordant habits, traits, and attitudes. For such a *cardinal trait, Wertheimer has proposed the designation "radix"*. The radix may never be sought on the activity level, for it lies at the root of activities. And, however inconsistent activities may seem to be, they are congruent so long as they spring from the same root" (1, p. 357).

Whereas manifest behavior, if taken at its face value, stands for nothing but itself and describes only one expression, dynamic concepts may stand for complex patterns of data which they thus help to integrate.

By discounting incidental effects of transient situations, and by regrouping the forms of behavior in terms of the dynamics they have in common, rather than in terms of expressional techniques, we may arrive at a level of abstraction which would offer much greater chance for the discovery of general rules, or laws, of personality.

Some authors, who also agree that we should start from some thing which is more comprehensive than specific manifest behavior, argue in favor of a kind of total score based on a summation of specific items. It would, however, oversimplify matters if we regarded a drive as the mere summing up of a variety of behavioral manifestations. The fact that certain manifestations may probably fully substitute for others renders the interrelationships of manifestations much more complex than would be expressed in the concept of summation. Due to the principles of alternative and of minimal (inhibited) manifestation, such a procedure would offer little in the way of finding what is dynamically significant. Short sample observation of two children may come to similar or even the same results in regard to many gross features of behavior, although the dynamic situations are quite different and lead to different prognoses of the two children.

We agree with Murphy, Murphy, and Newcomb in this point. "Much confusion in the measurement of personality can result from the attempt to define the end result of many traits by assuming that their results are somehow 'pooled' at the level of overt behavior." "Sympathy at the level of direct observation may arise from all sorts of different causal factors functioning at another level" (14, p. 302). "We have therefore to conclude that in relation to many problems in social behavior the usual procedure in working from the simple to the complex has led to difficulties. The varieties of behavior may be simply and clearly defined and reliably measured, yet fail altogether for purposes of prediction. This often occurs because what is 'simple' as ordinarily conceived is not 'central'" (14, p. 306). If we want to have a psychology of personality within which essentials are caught, relations are found, predictions are possible, we cannot avoid consideration of the "central."

Since the concepts of motivation are used here as generalized, abstract, inferences from the particularities of situational behavior, the question regarding specificity versus generality of personality variables should be mentioned briefly. G. W. Allport, Murphy, *et al.,* Stagner, and others in discussing this problem on the basis of the available empirical material assume that there are variables of significant generality on the motivational level.

> "That there are some factors common to many kinds of social behavior is beyond any doubt. The experiments of matching voice, gait, handwriting, trait scores, and personality sketches indicate, however, that the central forces are greatly deflected, and diversely so, as they influence the various behaviors. Common cores of personality seem to have been more successfully seen in terms of certain conceptualized organizational trends than as all-permeating traits of objectively measurable type." (14, p. 869.) "Our case for the existence of traits, therefore, must be worked out on the assumption that they correspond to implicit generalized responses or response tendencies, not given directly in behavior, but abstractable from behavior by an observer who is willing to interpret these specific responses in terms of their significance for an implicit pattern, the existence of which can only be inferred." "Also, we find that the person who uses now one, now another of these devices may still be acting in a psychologically consistent manner with reference to some subjective pattern of behavior" (17, pp. 117-118).

Our drives are on the level proposed by both of these authors.

G. W. Allport likewise assumes general tendencies in individuals, but doubts the value of abstraction of the type of "needs" or drives. In connection with his discussion of Murray he writes:

> "Two men, for instance, may be animated by a strong need for abasement; one perhaps becomes a sexual masochist, the other a well-disciplined monk. Does it not seem unnecessarily

> abstract to assume one common need in these contrasting cases?" "The need is not one for abasement in the abstract, but for a special, personalized form of self-surrender, in which the actones play an integral part with the need" (1, p. 240-241).

We consider his argument important. In fact, the relation between drives and actones (i.e., the behavioral manifestations) will be our main problem. But still, abstract as these variables may be which disregard the behavioral specificities, in another sense they can be rather specific. This can best be illustrated by referring to data such as dreams, fantasy, or the history of the individual. Without postulating the need for abasement in both the sexual masochist and the well-disciplined monk, we would wonder why they both have the same fantasies, and we would be unable to relate to their personalities their similar traumatic experiences of childhood, a circumstance highly probable in view of our general clinical knowledge. The differences in their behavior could probably be accounted for in terms of some other specific dynamic variables. In short, motivational tendencies are general and abstract only as far as the behavior from which they are inferred is concerned, but they have a specificity of their own in view of which behavior seems general and ambiguous in its meanings.

D. Problems of Approach to Motivational Tendencies

We are using the term "drive" for consistent tendencies manifest in alternative and even inconsistent behaviors. With the physiological approach to drives practically limited to such basic biological tissue needs as hunger or sex, there seems no other way to approach motivational tendencies than by inference from external facts. In some cases such inferences are made from the history of the individual (e.g., in the case of psychoanalysis) (4) or from the actual stimulus situation (e.g., when deprivation from food for a certain length of time is taken as a substitute for direct knowledge of the state of hunger). In other cases motivation is inferred from certain actions and results which have been found to issue from the individual (e.g., McDougall's system of instincts, or Murray's concept of needs). Some of the approaches suffer from the fact that behavior trends are, in an almost postulatory fashion, projected directly back into the subjects as motivators, without due consideration of the ambiguities inherent in the relationships between drives and behavior.

The fact that empirical research in personality has so far paid comparatively little attention to motivational tendencies which are not directly biological, is probably due to the methodological difficulties in approaching them.

One possibility of approaching the motivational level may not seem to have been sufficiently exploited; that is factor-analysis. But objections similar to those which we have raised against the use of summation scores as a substitute for motivation variables, may be raised against the use of factor analysis in this respect. There is the fundamental difficulty that factor analysis dealing with clusters of variables offers no way of handling the problem of alternative manifestations.

Likewise, the experimental method does not seem to be the ideal approach to motivation. Experiments, like behavior observation, are limited to particular situations; the circumscribed observation afforded is usually not adequate for an accurate diagnosis of motivation.

Therefore, the present study did not have much choice in selecting methods by which to approach the motivational personality of adolescents. Essentially, the procedure consisted in inferring motivation from behavior observed in a wide variety of situations. "Intuitive" judgments about motivational tendencies were obtained in the form of standardized ratings from a number of judges well acquainted with the adolescents. These ratings, alongside of other, more rational, forms of inference about motivational tendencies, were utilized as a guide to dynamic personality.

By using intuitional inference instead of explicit inference, freedom was granted to the judges to utilize minimal cues alongside with conspicuous ones, and so permitting alternative manifestations when present, to exert influence.

Like all inferences, intuition has the general character of a hypothesis based on observations, rather than the character of an observation. It thus contains more of the element of subjectivity than a behavioral observation is supposed to possess. Synoptic understanding and empathy required on the part of the rater leave comparatively wide latitude to personal attitude and bias. This implies that the problem of statistical reliability (inter-rater agreement) will be the more urgent in the case of motivational ratings.

Furthermore, if we wish, as we do, to remain strictly within the limits of objective psychology even in the use of the essentially inferential data, we must recognize that the cues which have played a part in determining the raters' judgments cannot be adequately ascertained from their own statements about the cues they felt they used. Rather, these must be ascertained from a correlational analysis of the relation between motivational ratings and observed behavior.[9] The mechanics of the clinical intuition underlying motivational ratings may thus be reconstructed, at least in part, on an objective basis.

Justification for the use of motivational ratings must come largely from the results of correlational analysis. If it should turn out that self-reports and other projective data correlate higher with drive ratings than with situational data, or if multiple correlations or related techniques prove that the drives are more closely related to "families" of behavior manifestations, whereas previously available conceptual tools furnish no such possibilities for organizing behavioral data, then we may be entitled to raise drive ratings from the status of a preliminary and tentative technique to that of a crucial point of reference with definite functional significance.

A procedure thus outlined would follow a course somewhat opposed to the customary type of procedure. In the use of behavioral ratings, the variables of observation are explicitly known and explicitly defined to begin with and all the implications and correlations may or may not be supplied as a more or less desirable addition. The meanings of motivational ratings, on the other hand, are not explicitly delineated; they represent interpretations, not denotable data. There is no meaning in these ratings, as far as objective psychology is concerned. Thus a first essential task is the determination of their meanings from their relationships to the more primary, more denotable data.

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[9] With respect to a closely related problem, Murphy, Murphy, and Newcomb have this to say: "But if there are 'levels' of personal characteristics, some of which are more easily observed but probably less important than deeper ones which exert a constant directing force upon personal behavior, we are in need of a clearer hypothesis as to what these deeper forces are, how they express themselves in external observed trends, and how the measurement of the latter may guide us in the understanding of the former" (14, p. 303).

The utilization of intuition and of related free forms of interpretation in psychology is by no means an innovation. It is the standard procedure of clinical psychology, in its evaluation of single cases by single clinicians in terms of motivational patterns. The motivational ratings discussed above could as well be called "clinical ratings." Their advantage over the customary clinical judgments is, however, fourfold. First, the use of a rating scale permits quantification. Second, several judges can be used simultaneously, giving judgments in comparable terms, so that their "average hypothesis" can be used instead of hypotheses of a single judge. The problem of reliability can thus be approached. The clinician uses the "bias" of one observer, namely of himself; in our case it is the average and thus the more impersonal "bias" of several observers. Third, the clinician relies on assumed relationships between cues and interpretation and often these assumptions of relationship are made only implicitly; here an attempt is made to analyze objectively the cues which have determined the interpretations of the raters. Fourth, the number of subjects can be increased, with comparability of measures maintained. In consequence, statistical treatment is feasible.

E. Murray's Study of Needs

A recent study in personality using drive ratings on a large scale and in a systematic fashion is Murray's Harvard study (15). He strongly emphasizes the importance of "central" underlying dynamics as contrasted with "peripheral" manifestations in overt behavior. The writer derived much stimulation from Murray's book, yet the procedure in this study differs in many important points from his. In spite of his clear view of the problem, in practice he does not always avoid conceiving of "needs" as intra-personal forces directly corresponding to certain classes of extra-personal behavior effects and identified with them. Sometimes the two levels are clearly differentiated and the dynamic forces even thought of as not capable of being included in a behavioristic or operational scheme. For these two reasons he does not place what seems a necessary emphasis on the empirical analysis of the interrelationships between drives, as inferred from behavior at large, and the itemized behavior manifestations upon which the inferences, at least partly, are based. In the same vein Murray sometimes assumes a priori the validity of inferences about drives which can be obtained from fantasy or from overt behavior.

In the type of approach outlined above, however, the inferences about drives are based, implicitly or explicitly, on behavior, and are afterwards subjected to a statistical analysis of meaning in terms of behavior. After thus being objectively related to behavior, they are utilized for their cardinal purpose, which is the validation of self-reports and projective material. Our procedure thus runs in a direction contrary to that of Murray, who presupposes knowledge of the meaning both of the drives and of the projective material. This may in part help us to understand the relative scarcity of quantitative data concerning problems of validity in Murray's book.

Subsequent attempts to quantify Murray's approach have likewise not withstood the temptation to identify needs and manifest behavior. The concept of "manifest drive," summarizing common features in overt behavior, is an example. In failing to transcend the description or direct categorization of behavior, it loses one of the main advantages to be gained from the concept of drives. It still takes behavior at its face value. The concept of manifest drive, indeed, obscures the fact that drive and manifest behavior refer to qualitatively different levels of abstraction, not merely to different degrees of generality or comprehensiveness. Not before we have conceived of behavior as a varying alternative set of expressions or "techniques" in the service of inferred motives, have we adequately introduced the concept of drives.

In the ratings of "manifest needs" used by Sanford,[6] behavior is taken at its face value. Yet the ratings are based on longer observation and items yield interesting behavioral syndromes to which we shall refer later. Furthermore, Sanford compares manifest needs displayed in behavior with needs inferred from fantasies. The correlations are found to be low. The assumption underlying this study is that closer relationships could be found only by comparing projective material with "central" (as contrasted with "manifest") drives. Some indications in this direction will be presented in Chapters IX and X.

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[6] The author recently had the privilege of reading the chapter on syndromes from the manuscript of the forth-coming monograph, *Studies in Child Development,* by Nevitt Sanford (in press—Society of Research in Child Development Monograph).

F. The Present Study

The California Adolescent Growth Study collected over a number of years the following main types of standardized data: Physiological and physical measurements, achievement tests, ratings by adult raters of the subjects' behavior in social situations, judgments by classmates (reputation records), the subjects' self-reports (e.g., Adjustment Inventory, interest, and attitude tests), and "projective" material (e.g., stories, compositions, art products).

The present writer was interested in interrelationships among these data and especially in the relationships between the observed behavior of the children and their direct and indirect self-reports. Correlations between such sets of data have been found, on the whole, to be rather low; the meaning of the self-reports thus remains unclear.[7] This finding may not seem altogether surprising if one considers that these two sets of data reflect different aspects of the personality.

By a preliminary study of the qualitative, free comments made by the observers, which clearly seemed to refer to motivation as an explanatory principle, the present writer was led to believe that an important clue for uncovering relationships might lie in the reference to these fundamental characteristics of the subjects' personalities. In the present study, ratings of "drives" were used as a more systematic measure of the opinions which found partial expression in free comments. These interpretative ratings were based on wide knowledge of the children's behavior, excluding, however, indirect performances such as self-reports and projective materials, in order to maintain the independent status of these for purposes of comparison. An opportunity for approaching the motivational level is offered in longitudinal studies such as the California Adolescence Study, where children are observed over a long period and become very well known to the observers.

Murray's book (15) had just come out and seemed to furnish an adequate set of categories which could be used to characterize the motivational personality. From Murray's list of needs a selection of nine categories was made with minor modifications. The categories selected were those which seemed to possess the greatest promise for serving as foci of reference for the manifest data collected in the Adolescence Study.

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[7] Pointing toward the consistency of these reports and their low validity, Vernon, however, concludes "the self-rating tests do measure something, though not perhaps what the authors of tests generally assume." P. E. Vernon, The assessment of psychological qualities by verbal methods, *Med. Res. Counc.*, 1938.

This list, including brief definitions (see Chapter II), was given to three members of the staff well acquainted with the adolescents over a period of years. They all had participated in characterizing the adolescents in free comments. The three judges were asked to rate the subjects (see Chapter II) in terms of this list, thus reorganizing and completing the picture they had laid down previously. They were asked to forget about manifest behavior and to group the children according to assumed motivation rather than according to similarities of displayed techniques. The extent to which our results are limited to a group of adolescents only and even to a group of adolescents in a specific cultural set-up and the extent to which they are more generally valid will have to be decided by comparison with further studies.

The evaluation of these drive ratings proceeded in the following five steps.

First, the agreement between the independent judges (which is one aspect of the reliability of the ratings) was computed (Chapter III). Differences of opinion about the subjects are discussed in the light of (*a*) the judges' conceptions of the drives, (*b*) their (the judges') personalities as diagnosed by additional ratings made especially for this purpose, and (*c*) their emotional attitudes toward the children (Chapter IV).

Second, drive ratings were statistically correlated with one another (Chapter V).

Third, the average ratings from the three judges are correlated with ratings of manifest behavior in order to find the objective meaning of the motivational ratings. One group of ratings of manifest behavior was selected from ratings of social behavior in specific situations. A second group of ratings deals with manifest, but more constant, general traits and attitudes of the subjects. The hypothesis of complex relationships of the either-or type between drive ratings and ratings of manifest behavior was borne out by using the results of multiple correlation technique. Various other statistical means, including correlations between individuals, were also employed (Chapters VI, VII and VIII). Furthermore, whole drive-patterns are compared with behavioral patterns.

Fourth, drive ratings validated in terms of behavior are correlated with self-reports of different kinds, direct and indirect. The direct are represented chiefly by the "Adjustment Inventory," the indirect by evaluation of projective material. It was hoped that motivational ratings might furnish the necessary bridging link between behavior data and self-report (Chapters IX and X). These correlations will be crucial in showing the predictive value of the drive ratings for reactions of the children, other than those reactions used for inferences of the drive ratings. On the other hand, these correlations may throw light on the meaning of the self-reports.

Fifth, a brief and very sketchy account is given of some relationships of the rated drive patterns of the children to environmental data such as attitudes of parents toward the child, their "social mobility," etc. (Chapter X).

In conclusion, the present study uses statistical methods in a domain which until recently has been chiefly reserved to the clinical, idiographic approach. The attempt is thus made to combine exactitude, characteristic of the statistical approach, with the intuitive insightfulness, characteristic of the clinical approach. The general tendency of this study is thus in line with those forms of investigation which tend to emphasize those objective, though sometimes remote, features of behavior which are most significant for the individual, rather than the most obviously, conveniently and safely observable features of behavior (21, 22). The aim of the study is to contribute toward the establishment of a motivational psychology in which drives are objectively and quantitatively defined.

II. PROCEDURE

A. LIST OF DRIVES AND METHOD OF RATING

The nine drives mentioned in the Introduction, adapted from Murray's list of "needs," were defined as follows:[8]

(1) *Drive for Autonomy*

Striving for independence and freedom; desire to be free from social ties, to shake off influence, coercion, and restraint; relatively little care for conventions and group ideology; tendency to act as one pleases.

(2) *Drive for Social Ties, Social Acceptance*

Desire to be generally well-liked; to conform to custom, to join groups, to live sociably, to be accepted by a group in any form, to make contacts.

(3) *Drive for Achievement*

Desire to attain a high standard of objective accomplishments; to increase self-regard by successful exercise of talent, to select hard tasks; high aspiration level. (Rating scale starts from "no desire to accomplish something outstanding" and ends with "excessive demands on himself.")

(4) *Drive for Recognition*

Desire to excite praise and commendation, to demand respect, social approval and prestige, honors and fame.

(5) *Drive for Abasement*

Tendency to self-depreciation, self-blame or belittlement; to submit passively to external forces, to accept injury, blame, criticism, punishment; tendency to become resigned to fate, to admit inferiority and defeat, to confess, to seek punishment and misfortune; Masochistic tendency.

(6) *Drive for Aggression*

Desire to deprive others by belittling, attacking, ridiculing, depreciating.

(7) *Drive for Succorance*

Desire for support from outside; from people, institutions, or supernatural agencies.

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[8] Seven out of the nine drive items are taken over almost literally from Murray. Out of the remaining two, for one the name is changed ("Social Ties" instead of Murray's "Affiliation") and the other, the "Drive for Escape" is elucidated in a partly different manner. The items were chosen on the basis of their promise as a help in organizing and validating some of the material available. No claim is made to completeness, balance, or basic character of this selection.

(8) *Drive for Control (Dominance)*

> *Desire to control one's human environment,* by suggestion, by persuasion or command.

(9) *Drive for Escape*

> *Tendency to escape all unpleasant situations;* to avoid blame, hardship, etc., to project own failures on others or on circumstances; to gain immediate pleasure with inability to postpone pleasure; use of fantasy, etc.

This list neither claims to be a complete representation of motivational tendencies, nor can the various categories be expected to be independent of one another. A discussion of the latter problem will follow in Chapters V to VIII. These preliminary definitions do not provide a complete indication of the nature of the drive categories. This will be determined in greater detail through a posteriori analysis of the results undertaken in these chapters.

The motivational factors can be, and in clinical practice commonly are, used to describe dynamic tendencies which differ in pervasiveness, "strength," or urgency for different individuals. A fundamental assumption of the following study is that these individual differences can be translated meaningfully into a statement that one individual has more drive for Abasement or Aggression than another individual.

Each drive was to be rated on a five-point scale. A rating of "1" was to represent the highest degree, a rating of "5" comparative absence (lowest degree) of the drive in question.

The ratings were made in written form by the three judges independently. The material presented in this monograph is based on these independent ratings averaged for the three judges except when the interest is in the individual differences between the single raters.

Several months after the original ratings had been made, the three judges discussed, in a joint meeting, the rating of each case with the purpose of obtaining a single rating on each drive to which they all could subscribe. This procedure is similar to that used in Murray's diagnostic council. These "conference ratings" are, however, referred to only occasionally in this study for purposes of comparison.

In the definitions given to each of the drive variables, one phrase is not meant necessarily to imply the next, but is rather to be understood as one of many possible alternative manifestations. Such a manner of exemplification is necessary wherever an item specified on the motivational level has to be tied to items specified on the behavioral level. The casual character of the definitions is intended to prevent the notion of the drives from becoming too rigid in behavioral terms. Its purpose is rather the opposite, namely, to loosen, in the raters' conceptions, any explicit or implicit notions of constant relationship between drive and manifestation.

A possible objection may be that anticipating the principle of alternative manifestations is a begging of the question. Or it may be said that the implied functional unity of each drive in our list is a thing to be proved rather than to be assumed. Our answer is that the procedure is ultimately to be justified by its results. If the raters are capable of giving ratings which can stand the requirements of reliability and validity, something of functional significance must have been captured by them, though the exact naming of whatever has been caught may be open to further discussion. Thus far they are tentatively named after their main family of manifestations, e.g., the "drive for Aggression" is named after overt aggressive behavior in the customary sense of the word, which, however, by no means is its only or necessary expression. It is even possible that the drive for Aggression may come out in a disguise of manifestations which normally would be displayed by a "succorant" individual. Wherever "succorance" is only a "technique," the drive behind it is not succorance but another form of motivation, which will ultimately reveal itself in a set of behavioral consequences adequate, more or less, to its basic intent (see Chapter VI). The distinction between aggressive behavior as a descriptive variable and drive for Aggression as an explanatory variable, is thus fundamental.

In place of written instructions, the conception of the drive ratings as described above and in the Introduction, was discussed with the three raters at a number of meetings preceding the actual rating procedure. In fact the judges took an integral part in developing and clarifying the procedure and the meaning of the drive ratings.

As has been anticipated above, the judgments were to be based upon direct contact with the children, and not upon indirect sources (such as self-reports, fantasy material, etc.), in order to relate the latter by means of the drive ratings, to the personalities of the children. This restriction was possible as the ratings were made before a systematic study of the material for the whole group by the raters had begun. The rating scale was used as a means of summarizing what the judges "privately" think, or what their hypothesis was, about each subject, or what they otherwise would have used only in writing up an interpretative case study of individuals whom they observed over a long period of time.

A number of specific points relevant to possible misunderstandings were especially emphasized.

Thus it was agreed that actually attained status, per se, should in no case enter the drive ratings. As a result the ratings on the drive for Recognition, for example, do not necessarily describe the actual prestige or social status which characterize the position of the child relative to the group, but describe rather how strongly the child is motivated by the goal of prestige. Such an urge may sometimes be openly displayed; in other instances, however, it may be blocked from any behavioral outlet, except for a few indirect and subtle "minimal cues," due to interference enforced by inhibition, fear of failure, and other antagonistic forces. For instance, in judging a person's desire for affiliation, one need not consider the frequency of contacts actually carried through, nor even the frequency of the more or less tentative attempts in this direction, but should rather summarize one's "intuitive" impression of the underlying social urge. (Actually in our previous example of John, a high rating was given by all the three judges on the drive for Recognition as well as on the drive for Social Ties. This occurred in spite of his low behavior ratings on actual "social participation," "interest in social activities," and attempt to "gain recognition and attention.") In contrast to the behavioral ratings, the description was not to be guided by similarities or dissimilarities of displayed techniques but rather by similarities of inferred motivation.

Another specific point was the following: drive ratings of the same person may seem to contradict each other. For example, a subject may have a strong need for Aggression, which in its turn may lead to guilt feelings resulting in a need for Abasement. Thus it is quite possible for a person to be rated high on both Aggression and Abasement.

As stated in the Introduction, the list of drives as used in our study refers to a level of personality which stands behind the surface of overtly displayed social techniques but which is not as remote from behavior as the psychoanalytic concepts.[9]

B. THE SUBJECTS

Our subjects are members of a group of about 150 pupils of one of the large coeducational public schools in Oakland, California.[10] These children were studied from the fifth grade through graduation from high school. When they left high school, their average age was about 18.

Since for practical reasons the plan originally was to keep the sample limited, ratings of the nine drives were obtained for an experimental group of 95 adolescents, 49 boys and 46 girls. An effort was made to select these in a random fashion.

All material reported in this study is based on our experimental sub-group of 95 subjects unless otherwise indicated.

After most of the computations had been made, it was decided that drive ratings should be obtained for the whole group. Thus the remaining boys, 33, and girls, 40, were rated in the same manner as the original group. The representative character of our experimental sample is demonstrated for boys and girls in Table 1. The frequency distributions of drive ratings of our sample are compared with those of the whole adolescent group. The similarity between experimental and total group can be seen at a glance.

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[9] In more detail: the chief differences between our list and the classification of instincts as suggested by Freud is given by the following two facts: (1) Sex ("Eros") is included, if at all, only in what may be the sublimated form of drive for Social Ties. The chief reason for this omission lies in the fact that the self-report test, the validation of which was the author's original interest, did not contain much direct reference to sex. (2) Because of the fact that the "instincts" in the psychoanalytic sense may be said to be defined in terms still more remote from behavior than the present list of drives, aggressive, self-destroying and regressive impulses which are labelled in our list Aggression, Abasement, Succorance, and Escape may all be classified under the heading of the so-called "death instincts."

The drive for Achievement and Recognition primarily represent the self-preservative impulses which, aside from safeguarding biological integrity, find a more subtle expression in the direction of fulfilling an "ego-ideal." In an earlier phase Freud has used the term ego-instincts as opposed to id-instincts to characterize these kinds of tendencies. Striving toward Achievement and Recognition as well as the drive for Social Ties (Affiliation) are furthermore, according to psychoanalytic theory, to be considered as sublimations of the Eros-instinct (6, *6a*).

[10] The Adolescence Study selected children from five elementary schools in Oakland who signified their intention of going to the junior high school selected as the center of observation and whose families agreed to coöperate.

TABLE 1

PER CENT FREQUENCY DISTRIBUTIONS OF DRIVE RATINGS*

		Experimental Group					Total Group				
		1	2	3	4	5	1	2	3	4	5
Autonomy	B	4	33	44	16	4	9	23	44	20	5
	G	2	20	57	17	4	3	18	46	28	4
Social Ties	B	8	28	35	17	11	10	32	36	16	6
	G	13	48	31	9	0	10	46	37	7	0
Achievement	B	2	32	39	23	4	5	34	40	16	4
	G	4	17	41	27	11	5	19	39	31	7
Recognition	B	9	35	31	17	8	13	37	29	16	6
	G	13	24	35	24	4	12	25	33	24	4
Abasement	B	7	22	26	35	11	5	29	29	27	10
	G	2	24	37	26	11	2	20	41	27	9
Aggression	B	13	15	40	22	11	10	22	33	26	9
	G	8	28	30	22	11	8	27	27	25	13
Succorance	B	6	23	45	24	2	13	23	46	18	1
	G	8	39	33	20	0	9	32	37	22	0
Control	B	8	25	46	13	8	7	26	42	18	8
	G	13	35	28	21	4	10	27	30	27	5
Escape	B	15	35	26	25	0	14	34	31	20	0
	G	7	46	22	17	9	6	37	32	20	5

*The scores were grouped in the following way: 1=1, 1.3; 2=1.7, 2, 2.3; 3=2.7, 3, 3.3; 4=3.7, 4, 4.3; 5=4.7, 5. This arrangement was made necessary because of the odd number of discrete scores due to the averages of three judges' scores.

In order to determine more precisely the representativeness of our sample with respect to the drive distributions, chi square coefficients were computed using the frequencies of the total group as theoretical frequencies and those of the sample as the observed frequencies. The greatest discrepancy is that of the drive for Escape in girls. But even here the probability of obtaining a greater discrepancy due to chance is .05. (These probabilities range from .05 to .97 with a mean of .54 for girls and .39 for boys.) The distributions of the samples, therefore, do not deviate significantly from the distributions of the total group. A further confirmation of the representative character of our main sample may be seen in the fact that the coefficients of inter-rater agreement are similar for the two groups, as will be discussed in detail in Chaper III.

The drive ratings for our group were made one year after the members of the Study had graduated from the twelfth grade. While these ratings were necessarily based on impressions collected from observation over a period of years, an effort was made to weight the ratings with impressions gained during the last years of the Study. For example, if a rater felt that an individual had shown a great urge to be in the spotlight at the beginning of senior high school but had worked through this phase by the twelfth grade, he was rated on the basis of the twelfth grade behavior. However, the raters had the impression that in most cases the motivational tendencies did not change during the period of observation.

C. THE RATERS

The raters varied with respect to their previous experience in academic and clinical psychology. Two of the raters had a background in academic psychology, one of them was especially trained in child development. The third rater was a school counselor and had had a closer contact with psychoanalysis. All three raters were women. Two of them had observed the children in a variety of situations for seven years in close contact, one for four years. This fact was particularly important for ratings of motivational patterns which call for a many-sided knowledge of the subjects. Two of the raters had participated in previous behavioral ratings, and two of them had had contact with the families of the children.

III. DISTRIBUTIONS AND RELIABILITIES OF DRIVE RATINGS

A. Distributions

The frequency distributions of the average drive ratings for our group are shown in the left half of Table 1 for boys and girls separately. Though the judges were not specifically asked to keep a normal distribution in mind when they were rating, the majority of the distributions are not far from bell-shaped. There is, however, a tendency toward an increased frequency of the higher ratings ("1" and "2"), in the case of the drives for Social Ties,[11] Recognition, Succorance, and Escape for both boys and girls. Whether or not this distribution is due to the age of our subjects cannot be decided on the basis of our material. The particular combination of Recognition, dependency (Social Ties and Succorance) and a tendency to go off into unreality (Escape) is quite consistent with our general knowledge of adolescence (3, 25).

In general, the distributions for boys and girls are so similar that it has not seemed worth while to compute values for the reliability of differences. There is, however, a slight apparent tendency toward rating girls higher than boys in the drive for Social Ties, and toward rating boys higher than girls in the drives for Autonomy, Achievement, and Recognition.

B. Inter-Rater Agreement on Drives

Table 2 shows the inter-rater agreement (reliability) on the ratings of drives for all combinations of the three judges in terms of Pearson correlation coefficients computed for boys and girls separately. Their averages, computed by the squared *r* method, are listed on the right margin, followed by the averages raised according to the Spearman-Brown formula. The latter are to be interpreted as the correlations between the averaged ratings for these three judges and the averaged ratings for three comparable judges. Averages over the nine items are also given for each of the five columns in the table.

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[11] Throughout this monograph the terms designating the drive items will be capitalized and explicit reference to "drive for . . ." or "rating on drive for . . ." will frequently be omitted in order to simplify the presentation and discussion of the results.

TABLE 2
INTER-RATER AGREEMENT ON DRIVES (RAW AND RAISED)

Drive-Items		Combinations of judges *FxG*	*FxH*	*GxH*	Average *r*	Raised average
Autonomy	Boys	.32	.11	.38	.29	.55
	Girls	.17	.04	—.02	.10	.25
Social Ties	Boys	.47	.47	.69	.55	.79
	Girls	.43	.64	.40	.50	.75
Achievement	Boys	.19	.42	.46	.38	.65
	Girls	.37	.48	.44	.43	.69
Recognition	Boys	.39	.53	.51	.48	.73
	Girls	.22	.44	.54	.42	.68
Abasement	Boys	.42	.29	.51	.42	.68
	Girls	.45	.30	.42	.40	.67
Aggression	Boys	.50	.60	.51	.54	.78
	Girls	.38	.57	.39	.46	.72
Succorance	Boys	.40	.32	.35	.36	.63
	Girls	.16	.45	.30	.33	.60
Control	Boys	.60	.43	.36	.47	.73
	Girls	.47	.54	.52	.51	.76
Escape	Boys	.50	.61	.34	.50	.75
	Girls	.61	.42	.39	.48	.73
Average *r*	Boys	.44	.45	.47	.45	.70
	Girls	.37	.46	.41	.42	.67

Table 2 shows that for three judges combined[12] the drive ratings have a reliability of the order of .7, with the exception of the ratings for Autonomy and for Succorance, which tend to be somewhat lower.[13] Possible reasons for these differences are discussed in Section *C* of this chapter.

Next to Autonomy, Succorance shows the lowest, whereas Social Ties shows the highest reliability coefficients. The differences are interesting, yet not quite significant enough to justify detailed discussion or speculation. Among the various factors which reduce reliability is the tendency for drives to be manifested in various ways, in subtle ways, and often also in incongruous ways.

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[12] The combined ratings for all three judges have been used in all further work with the drive variables, unless otherwise specified.

[13] Examining the indices of reliability, we find that the maximum correlations possible for the drives to attain with other variables (omitting Autonomy) range from a low of .77 (Succorance, girls) to a high of .89 (Social Ties, boys).

The similarity between the reliability coefficients of boys and girls as contrasted with the variability of these coefficients between drive categories indicates that the reliability of measurement is determined by drive differences, whatever origin these differences might have, rather than by sex differences.

The averages for all the nine items are .45 for boys and .42 for girls, unraised, and .70 for boys and .67 for girls, raised. The three averages of the single combinations of judges show only minor differences in agreement. Though reliabilities are not as high as they might be, they appear adequate for the purposes for which they are used in the present research.[14] In our opinion, justification for the use of drive ratings in personality studies is not to be sought in their degree of reliability, per se, which is moderate, but rather in the expectation that they may prove to be a functionally relevant level of the personality. Obviously, however, a moderately high degree of reliability is necessary to make the use of drive ratings feasible.

Though the difference between boys and girls regarding reliability may not be significant, it is tempting to comment upon a possible cause of the difference. In the discussion of the relationship between drive ratings and behavioral ratings (Chapter VI) it will be seen that on the whole boys seem to display their drives more openly than girls. This may lead to a greater difficulty in judging motivational characteristics in girls.

A noteworthy feature of the coefficients of inter-rater agreement for drive ratings lies in the fact that they are of the same order of magnitude as those reported for manifest traits (20). This is in spite of the fact that they involve more complex concepts, a greater remoteness from immediate behavior, and the necessity for penetrating through the disguises by which people with different social techniques conceal their underlying motives.[15]

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[14] Murray (15) has already emphasized the satisfactory inter-rater agreement of drive ratings. In his book, however, he presents little quantitative evidence to support his statement.

[15] As mentioned in the Introduction, we do not always consider drive ratings more "general" than behavior. The specificity of the situation is indeed given up. But instead, there is reference to the specificity of a cause. Drive

C. COMPARISON WITH CONTROL GROUP AND WITH REVISED RATINGS

The inter-rater agreement was also computed for the remaining group of 33 boys who were rated shortly before the completion of this study and therefore were not included in our experimental group. In Table 3 the unraised averages of the reliability coefficients for each of the nine items are compared for the control group and our experimental group of boys.

TABLE 3
AVERAGE RAW INTER-RATER AGREEMENT ON DRIVES FOR BOYS, EXPERIMENTAL GROUP, AND CONTROL GROUP

	Experimental group	Control group
Autonomy	.29	.53
Social Ties	.55	.47
Achievement	.38	.31
Recognition	.48	.53
Abasement	.42	.46
Aggression	.54	.55
Succorance	.36	.38
Control	.47	.44
Escape	.50	.44
Average	.45	.46

Leaving out of consideration for a moment the drive for Autonomy, the agreement is rather close between our experimental group and the control group. The difference is never larger than .08. The averages for all nine drives for the two groups show almost identical values.

The good agreement between the groups is a further confirmation of the representative character of our experimental group, in addition to the evidence given in Chapter II.

The only major difference is with respect to Autonomy. For the control group, the coefficient is .53 and thus among the highest of the nine items, whereas in the main group the coefficient for Autonomy is lowest. As shown in Table 2, the main group of girls showed an even lower figure than the boys on Autonomy;

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ratings then would not necessarily benefit from the increase in reliability which is ordinarily attributed to a shift from more specific to more general rating categories.

few of the six correlations between the judges, for this drive, were even significantly different from zero.[10]

An explanation for this can be found in the following: striving for autonomy will in some cases mean a genuine drive for independence and freedom. In many cases, however, it will be a secondary reaction to one or more of a variety of frustrations. In discussing the rating procedure after the judgments on the main group had been completed, the item Autonomy turned out to be the chief point of difficulty, for this very reason. For those subjects in whom Autonomy appeared to be a reaction-formation, that is a motivational alteration, as defense against dependency or other weaknesses, the judges complained of uncertainty in rating the drive. Before the ratings on the control group were made, it was agreed that no motivational factors should be excluded on the basis of their origin.

Ratings of Succorance may also be interfered with by similar difficulties. A difference might lie in the fact that Succorance may often be more genuine than Autonomy and be camouflaged rather than created by reaction-formation. In any case the result would be a comparatively low inter-rater agreement.

Under certain circumstances some degree of indirection will have to be expected for all drives. However, the facts that the experimental group and control group are in fairly good agreement for all items except Autonomy, and that the averages are almost exactly alike, may be taken as evidence in favor of the assumption that further clarification of the raters' attitudes with respect to reaction-formations through further discussions, did not effect a decisive change in the ratings (except for Autonomy).

It is interesting that for this adolescent sample, Autonomy and Succorance are most difficult to rate reliably. The generally accepted clinical observation assumes that at adolescence there is both an increasing need for independence, and a strong need for security and guidance; these tend to conflict with each other, giving a confusing picture.

The original independent ratings were compared with the "conference ratings," i.e., the ratings upon which the judges had agreed after discussing each subject, subsequent to the original rating procedure (see Chapter II). As seen in Table 4, the correlation coefficients range from .65 to .92, further confirming the fact that the revision of the ratings did not lead to fundamental changes in the results.

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[10] The standard error of a correlation of zero is .143 for boys, and .147 for girls. This means that a correlation must be, roughly, about .36 or higher in order to be significantly different from zero.

TABLE 4

CORRELATIONS BETWEEN THE AVERAGES OF THE THREE INDEPENDENT RATINGS WITH "CONFERENCE RATINGS"

	Boys	Girls
Autonomy	.90	.76
Social Ties	.89	.88
Achievement	.65	.80
Recognition	.91	.89
Abasement	.86	.69
Aggression	.90	.92
Succorance	.78	.71
Control	.91	.87
Escape	.85	.92

IV. INFLUENCE OF JUDGES' PERSONALITIES ON DRIVE RATINGS

Tables 2 and 3 have shown that for most of the drive variables there is a fair agreement among the judges, so that the ratings could be used in a study of personality. The fact, however, that these correlations are far from perfect necessitates a discussion of subjective factors as possible determiners of unreliability. Since we are dealing with secondary interpretations on the part of raters, it is especially important to try to make explicit the "personal equations" of the judges.

There are three aspects of this problem that demand discussion. None of these aspects can be fully treated here, however, because *of the limited number of judges. The three points follow.* *Ratings* may be influenced differentially by: (*a*) the way in which the drive is conceived by the judge; (*b*) the degree to which the child is liked or disliked by the judge; and (*c*) the intensity with which the judge herself is motivated by the drives in question.

A. INTERRELATIONSHIPS OF DRIVE VARIABLES AS IMPLIED IN RATERS' EXPLICIT OR IMPLICIT CONCEPTIONS

Table 5 shows the correlations of each judge's ratings of the children on each of the drives. Thus for each cell of the table, representing a certain combination of drives. There is, for boys and girls separately, one coefficient for each of the three judges, six coefficients altogether. These coefficients may be taken as indicators *of the judges' feeling about the closeness of the two drives in question*, their compatibility or incompatibility. This table, then, can be utilized to discover for each judge the underlying theories about, or implicit definitions of, any drives in terms of the other drives. The individual differences in correlations may throw light, in the way of an objective analysis, upon the meaning of the categories to each of the raters.

As an illustration, let us consider the interrelationships of the ratings on Autonomy with the other drives for each judge. They are shown in the first row of Table 5. For Judge *G* there is a sizeable negative correlation of Autonomy with Social Ties and also with Succorance, for both boys and girls. This indicates some degree of mutual exclusiveness, in her opinion, of the two drives, at

TABLE 5

Raw Inter-Item Correlations of Ratings on Drives, for the Three Judges *F*, *G* and *H*

		Social Ties			Achievement			Recognition			Abasement			Aggression			Succorance			Control			Escape		
		F	*G*	*H*	*F*	*G*	*H*	*F*	*G*	*H*	*F*	*G*	*H*	*F*	*G*	*H*	*F*	*G*	*H*	*F*	*G*	*H*	*F*	*G*	*H*
Autonomy	(B)	.19	—.55	—.44	—.16	—.13	.00	—.04	—.45	—.12	.00	.24	.24	.47	.05	.15	—.16	—.44	—.21	.40	—.09	.37	.30	.05	.07
	(G)	.25	—.45	—.29	.10	.52	.34	.09	.00	.47	—.21	.16	—.16	.42	.17	.27	—.14	—.48	.03	.51	.25	.36	.20	—.01	.44
Social Ties	(B)				.23	.05	.24	.44	.70	.63	.19	—.26	—.05	.51	.24	.39	.51	.39	.16	.33	.45	.32	.36	.20	.42
	(G)				—.20	—.22	—.12	.21	.48	—.01	.06	—.00	.28	.27	—.03	.14	.40	.39	.31	.09	.09	.14	.45	.30	.11
Achievement	(B)							.81	.04	.43	—.06	—.56	—.30	.19	—.41	.07	.00	.13	.04	.37	.03	.47	—.07	—.46	—.12
	(G)							.52	.07	.45	.04	.07	—.32	—.08	—.02	.29	—.28	—.25	—.35	.25	.02	.48	—.38	—.37	.28
Recognition	(B)										—.17	—.15	—.26	.38	.47	.66	.16	.35	.24	.47	.57	.61	.14	.32	.55
	(G)										—.08	—.15	—.40	.26	.57	.61	.12	—.02	—.07	.49	.68	.81	.00	.60	.63
Abasement	(B)													—.12	.16	—.11	.43	.24	.20	—.28	—.54	—.21	—.08	.12	.00
	(G)													—.56	—.17	—.32	—.24	.32	.30	—.44	—.26	—.37	—.42	.05	—.08
Aggression	(B)																.26	.07	—.02	.76	.73	.71	.59	.55	.70
	(G)																.42	—.33	—.06	.68	.65	.68	.69	.57	.37
Succorance	(B)																			—.01	—.12	—.09	.33	.03	.26
	(G)																			.05	—.35	.00	.57	.08	.23
Control	(B)																						.41	.38	.43
	(G)																						.30	.48	.55
Escape																									

least in so far as they are manifested in this particular sample of cases. For Judge F neither of these two correlations nor any of the others is significantly negative. Thus in her mind the drive for Autonomy seems not to be incompatible with any of the other drives, including Social Ties and Succorance. Judge F shows positive correlations of Autonomy with Aggression and with Control, for which the ratings of Judge G exhibit no relationship. For our material, differences between correlation coefficients may be considered significant when about .4 or higher. The differences considered above are, on the whole, and considering the agreement for both sexes, of this order of magnitude.

For the interrelationships of the remaining eight drives, individual differences among the raters are not as marked as they are for Autonomy. This is, of course, consistent with the fact that these *other drives show considerably higher inter-rater agreements than* does Autonomy (see Chapter III). In fact, the lack of inter-rater agreement on the latter drive can be traced to its source by the analysis just presented, showing in greater detail the absence of a unified conception[10] of the drive for Autonomy. Individual differences in the notions about Autonomy discussed above may also be indirectly tied up with the uncertainty of opinion concerning the status of reaction formations as discussed in Section C of Chapter III. As we pointed out there, this uncertainty disappeared after a clarification of the rating policy so that ratings on Autonomy for the control groups showed a reliability as high as those found for the other drives.

The interrelationships of the eight remaining drives as exhibited in Table 5, will not be discussed here in the same detail as their relationships with Autonomy. It is of some interest, however, to examine the results of a graphic cluster analysis (23) (see Figure 1) in which those pairs of items were selected, for each judge, which showed a close relationship to each other in terms of their pattern of correlation with the remaining items. This procedure is more comprehensive than is reference to single correlations in Table 5

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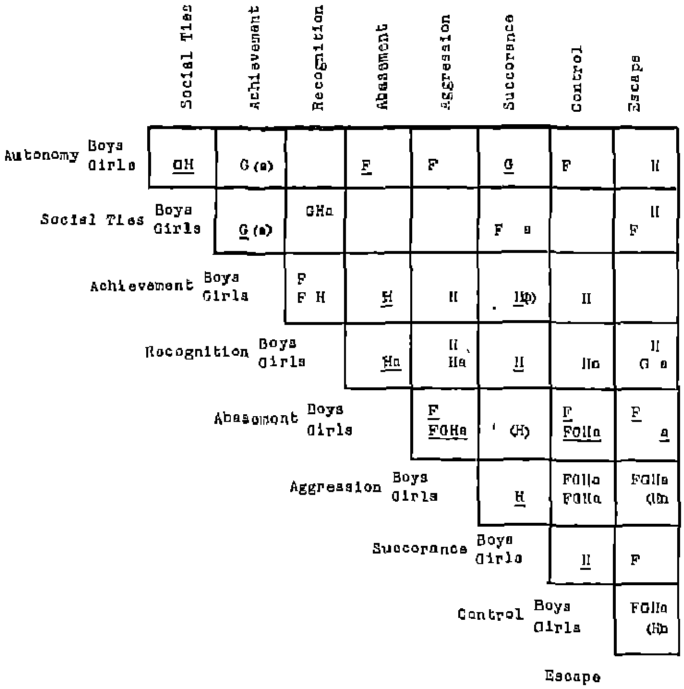
[10] Another source of the differences found may be in the fact that the relationships of each judge to the children varied with respect to intimacy. A related source may be the fact that the three raters refer to somewhat different depth levels of motivation.



	Social Ties	Achievement	Recognition	Abasement	Aggression	Succorance	Control	Escape
Autonomy Boys Girls	GH	G (a)		F	F	G	F	H
Social Ties Boys Girls		G (a)	GHa			F a		H F
Achievement Boys Girls			F F H	H	H	H(a)	H	
Recognition Boys Girls				Ha	H Ha	H	Ha	H G a
Abasement Boys Girls					F FGHa	(H)	F FGHa	F a
Aggression Boys Girls						H	FGHa FGHa	FGHa (Ha)
Succorance Boys Girls							H	F
Control Boys Girls								FGHa (Ha)
Escape								

FIGURE 1

Clustering of Rated Drives

Symbols indicating inverse relationships are underlined. Symbols in parenthese indicate that relationship is not clear cut.

since it is based on the pattern of relationship with all the other items instead of on only one direct relationship.

The capital letters in the cells refer to the judges *F, G, H*. The presence of one of these letters in a given cell indicates that for that judge, the two drives intersecting in the cell have similar correlation profiles. That is, the two drives have a similar meaning or at any rate a similar expression in this sample. If the similarity is high, but the relationship between the two drives is negative, the letter is in italics. The small letter *"a"* has the same meaning as the capital letters, but for the average of all three raters, instead of for a single rater. Discussion of drive profile similarities of the averaged ratings will be reserved for a later chapter (see Chapter V).

To illustrate: Judge *G* is entered, in italics, in the cell intersecting

Autonomy and Social Ties. This means (*a*) that the relationship between these two drives is very close in the mind of Rater *G*, as indicated by their similar correlation profiles; but (*b*) the relationship is negative *in the mind of this rater—i.e., high on Autonomy* tends to imply being low on Social Ties, and vice versa. Judge *H* is designated in the same cell, and in italics. This means that *H* has the same conception of the relationship between these two drives as *G*. Both of these entries are made opposite "Girls," and not "Boys." Therefore, this conception holds only for the girls. Thus, girls rated high on Autonomy by the two judges will probably be rated low on Social Ties.

A first aspect of individual differences between raters is the number of entries for each judge in Figure 1, indicating their respective tendencies to bring drive items together conceptually. In this respect Judge *H* surpasses the other two judges with 25 entries, whereas Judge *F* receives 17, and Judge *G* with only 12 entries, tends to regard the drives as more independent of each other. The number of entries for negative relationships alone gives the same result.

It seems noteworthy that the number of entries (disregarding "*a*"'s) in the rows representing girls is more than twice that for boys (37 versus 18). Apparently more interdependencies are seen in girls than in boys. Whether this is due to less varied forms of drive organization in girls or to the fact that the raters, as women, have a greater inclination to see motivations interrelated in girls than in boys, are questions which need not be settled immediately.

Regarding the details of individually conceived relationships among drives, we find that Judge *H* shows a much greater tendency to relate drives to Achievement, Recognition, and Succorance than do the other judges. This may be seen by following through the columns and rows representing each of these three drives. For Succorance the relationship is mostly inverse. For Judge *F*, relatively close relationships, all negative, can be found with Abasement.

The previous discussion of differences in the raters' conceptions of Autonomy is clearly seen in the light of Figure 1.

Among the relationships holding for the averaged ratings of the three judges, the extensive clustering of Aggression, Control, and Escape for both boys and girls, is especially conspicuous. Furthermore, a strong inverse relationship is evident between Abasement, on the one hand, and Control, Aggression, Escape, and Recognition, on the other, especially for girls. These and other general relationships will be discussed in Chapter V more extensively.

B. Influence of the Explicit Emotional Attitudes of the Raters toward the Subjects

After completing the ratings on drives for the main group, the judges were asked to indicate their likes or dislikes for the children

TABLE 6

Raw Correlations between Ratings on Drives and Raters' Preferences of Children

			Judges	
		F	*G*	*H*
Autonomy	Boys	.22	.05	.18
	Girls	.11	.32	—.09
Social Ties	Boys	—.25	.13	—.06
	Girls	—.20	—.19	.07
Achievement	Boys	—.03	.28	.21
	Girls	.36	.30	.30
Recognition	Boys	—.31	—.14	—.04
	Girls	.00	—.39	—.28
Abasement	Boys	.33	—.06	.05
	Girls	.36	—.04	—.02
Aggression	Boys	—.26	—.56	—.24
	Girls	—.46	—.29	—.19
Succorance	Boys	—.25	—.08	—.00
	Girls	—.59	—.35	—.30
Control	Boys	—.20	—.19	.19
	Girls	—.18	—.25	—.18
Escape	Boys	—.46	—.66	—.25
	Girls	—.64	—.52	—.39
Average (signs discarded)	Boys	.28	.32	.16
	Girls	.38	.32	.23
Average (signs considered)	Boys	—.21	—.28	—.03
	Girls	—.29	—.24	—.18

on a five-point scale.[17] Correlations of these preference ratings with the drive ratings were then computed for the individual judges. They are shown in Table 6.

Many of the coefficients are close to zero, showing that for several of the drives, the ratings are not tied up with verbalized emotional preferences. The major exceptions are for Aggression, Escape, and Succorance, the former two showing sizeable correlations for boys and girls, the latter for girls in at least one of the three raters.

The coefficients for the three drives mentioned above, Aggression, Escape, and Succorance, are all negative, showing dislike for those who rate high on these drives. As shown in the bottom row of the table, algebraic averages (from squared *r*'s, but respecting the original signs) for all the nine drives show likewise a consistently negative trend, pointing, though probably not significantly, toward a general predominance of aversion to strength of the drives in our list.

The question may be raised as to whether or not dislike of the presence of a drive or of some tendencies associated with the drive, implies poor judgment about this drive by the judge. Among the most marked individual differences in Table 6, we find a particularly strong dislike of Aggression and Succorance in girls by Judge *F*. Among the remaining two judges the corresponding figures for girls are, though still negative, considerably closer to zero, especially in Judge *H*. Turning back to Table 2 it can be seen that the agreement between Judges *F* and *H* on the corresponding values is better than the figures for the agreement between the remaining two combinations of judges. Thus at least in this instance, a high degree of aversion toward a drive does not go with unusual discrepancy of judgment when the judgment of the least prejudiced rater is used for comparison.

In order to find more general evidence regarding this question, correlations were also computed between disagreement in judgment and disagreement in liking, using the averages of all differences. The coefficients are close to zero, namely, .18 for boys and —.07 for girls. Computed for each of the drives separately, these coefficients range from —.14 to .22.

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[17] This type of rating was introduced by C. McC. Tryon.

Both of these lines of evidence point toward the conclusion that explicit liking or disliking of the subjects on the part of our judges did not enter as a seriously disturbing factor in the ratings of drives. In order to decide more generally about this question, however, it will be desirable to use a large sample of judges.

It may be added briefly that the inter-rater agreement on emotional preference is not as high as one might be inclined to expect. The values in Table 7 range from .28 to .50. The least agreement is between Judges *F* and *G* on boys. This is in line with the generally lower agreement among the two judges as shown in Table 2.

TABLE 7
INTER-RATER AGREEMENT ON PERSONAL PREFERENCES

	Combinations of Judges		
	*F*x*G*	*F*x*H*	*G*x*H*
Boys	.28	.50	.44
Girls	.46	.47	.49

C. RELATIONSHIPS BETWEEN RAT' .S' PERSONALITIES AND DRIVE RATINGS GIVEN

The problems discussed in this section deal with the relationships between (*a*) drive ratings by each of the three judges, and (*b*) drive ratings referred to the judges themselves. The latter measures were especially introduced for the purposes of the present comparisons. They can be subdivided into self-ratings and ratings obtained from three other members of the Institute of Child Welfare Staff.

Some of the problems to be discussed are best illustrated by referring to Figure 2. In this figure, only those four of the nine drive variables are included which show the trends in question most clearly. The corresponding quantitative evidence based on all drive variables is presented in Tables 8, 9, and 10 along with material about additional problems. In Figure 2, frequency distributions have been drawn of ratings on our five-point scale given to the children by each of the three judges. Distributions for the girls are represented on the left, those for the boys on the right half of each of the four sets of graphs. At the top of each graph the rater's own standing on the drive in question is indicated. The upper row

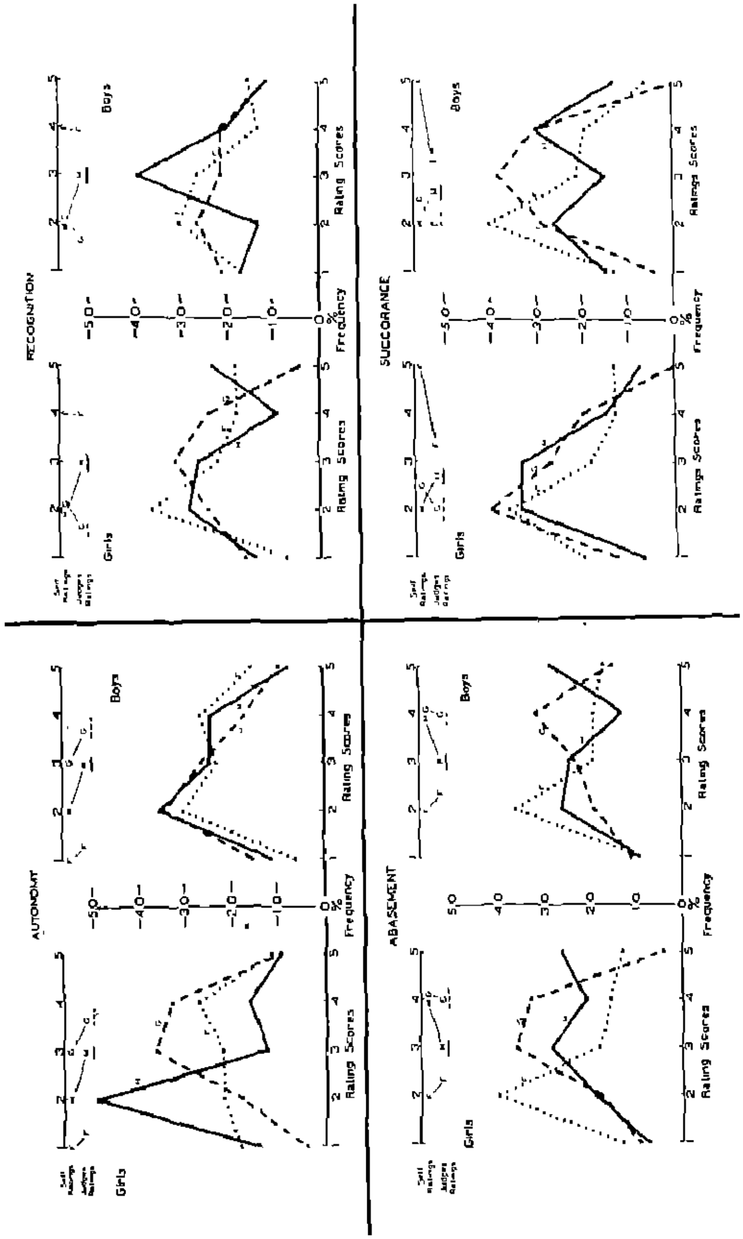
AUTONOMY
RECOGNITION
ABASEMENT
SUCCORANCE
Self Ratings
Judges Ratings
Girls
Boys
1
2
3
4
5
Rating Scores
% Frequency
5.0
4.0
3.0
2.0
1.0
0

FIGURE 2

indicates her position according to her self-rating, the lower her position according to ratings obtained from the other members of the staff.

The first problem to be discussed is the following: Do judges possessing certain drives tend to project these drives into the subjects or do they rather rate by "contrast," that is, rate people as if they were *different from themselves*?[18] Murray states he finds contrast rather than projection, though the tendency is said not to be very marked. More detailed questions under this heading are the following: Does projection (or contrast) occur relative to the judge's ratings as given by others, or does it occur relative to self-ratings? In other words, is it the "objective" personality or rather the image of the self which is projected? And does projection (or contrast) occur more readily when individuals of the same or of the opposite sex are rated?

We point first to some tendencies graphically presented in Figure 2, using only rough criteria. Rater *F* seems to judge by contrast in the case of Autonomy, Recognition, and Succorance, but by projection in the case of Abasement. This follows from a comparison of the peaks of *F*'s (dotted) distributions (relative to those of the other two judges), with her own standing on the drive in question. Only in the case of Abasement do the peaks of her distributions correspond directly to her own rating on Abasement. For the other three variables, her peaks are on the opposite side of her position. In the case of Autonomy, *F* is high (ratings obtained are close to "1") but she tends to give low ratings to the subjects. In the case of Recognition or Succorance on the other hand, contrast occurs in the opposite direction; that is, *F*'s own low standing on this drive is in contrast to her inclination to assign high ratings (rating "2").

It is clear from the upper portions of each graph that *F*'s self-ratings agree very well with the ratings she obtained from the other three judges in the case of Autonomy, Recognition, and Abasement, so that for these three variables no distinction needs to be made between "objective" and "subjective" personality. There is, however, a marked discrepancy between her obtained ratings and her self-rating in the case of Succorance. The phenomenon of rating by contrast holds for this item more clearly with respect to self-ratings.

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[18] The terms projection and contrast have come to be used in the psychological literature to designate the inclination, on the part of a rater, to assign qualities in his ratings which are, respectively, similar or opposite to those he himself possesses, regardless of the question of whether or not his ratings become more or less "true" by doing so. On the basis of our material we *cannot differentiate between the following two types of projection*: (1) a distortion of perception due to unconscious mechanisms, and (2) a coincidental similarity between the raters' drives and the mode of the group.

Among some of the other features, especially noticeable is *G*'s tendency to rate boys by projection on Abasement; or *H*'s tendency to project her self-rating on Autonomy, but to project her "objective" rating on Recognition, with respect to the boys.

Instead of following up other single instances of projection or contrast in Figure 2 or in the five drive variables not represented there, we shall now attack the problem in a more systematic fashion. In brief, the method used is to correlate rank-orders of the nine drives ranked (*a*) according to each judge's rating of the children, and (*b*) according to her own ratings on the drives. In Table 8 rank-order correlations between ratings given and ratings obtained (including self-ratings) are presented. Averages of all the ratings given by a judge were computed, for each of the drive variables separately, and these averages were then placed in a rank order. The drives were also ranked, for each of the judges separately, with respect to the average ratings they obtained from the other three judges, and also with respect to their self-ratings. Correlations between rank-

TABLE 8

Projection and Contrast in Raters' Judgments*

		Rank-Order Correlations: Average rating of children vs. Ratings of judges		
		F	*G*	*H*
Judges rated by Others	Boys	—.23	.10	—.01
	Girls	—.22	.59	.27
Judges rated by Self	Boys	—.20	.33	.63
	Girls	—.23	.70	.68

*The figures in the table are rank-order correlations for each judge between the following two sets of rankings of the nine drives: (1) according to the average of all ratings given to the children by a judge for each drive; and (2) according to the ratings of the judge herself on the nine drives. The latter have been ranked in two different ways and separate computations were made for each: (*a*) according to the average, for each drive, of the ratings given her by the three other judges, and (*b*) according to her own ratings of herself.

ings of the nine drive variables were then computed according to the Spearman rank-difference formula.[10] In Table 8 positive correlations thus indicate a tendency to project, negative correlations a tendency to rate by contrast. Due to the way in which these figures were arrived at, however, there is no possibility of deciding which of the variables were more, and which less, susceptible of projection or contrast. Only the general tendency of a rater in the one or the other direction is represented in these figures.

Of the individual figures in Table 8, only the comparatively large figures should be taken seriously. The most striking result is the inclination of Rater *H* to judge both boys and girls in the same way she judges herself. This tendency to "project" has already been illustrated by a number of references to single drive variables in discussing Figure 2. In Rater *G* we also find a tendency to project, but in her case, this tendency is limited chiefly to girls and holds for both her "subjective" and "objective" personalities. In Rater *F* there is a slight but consistent tendency to rate by contrast. Coefficients are all about —.2 for boys as well as girls, for her personality as seen by herself as well as by the other three raters. Though the presentation in Figure 2 is not directly comparable to what is expressed by the correlation coefficients in Table 8, *F*'s tendency to rate by contrast has already been noticed in discussion of this figure.

From the evidence in Table 8, it can be said that on the whole the tendency toward projection is stronger than the tendency toward rating by contrast. However, due to the fact that this statement refers to a sample of three judges only, it can by no means be generalized. Moreover, it seems clear that we may not expect a very consistent trend from rater to rater in either direction. It can, furthermore, be said that among our three rates, two show a stronger tendency to project when rating individuals of the same sex than when rating the opposite sex, and that the tendency to project the personality as seen by the self is stronger than the tendency to project the personality as seen by others.[20]

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[10] To be sure, these correlations are based on a population of only nine items. It has, however, to be held in favor of our procedure that the rankings of the drives are in each case based on averages of several or even many single reactions. Furthermore, the drive variables are not drawn at random from a large population of drives but rather they represent a careful selection of items, with respect to the special purposes of the study. Considerations regarding the distorting effects of sampling errors thus are far less important than in the case of a study where the population consists of persons, and the reliabilities of our coefficients is probably much better than could be ordinarily expected from the use of rank-order correlations with a small population. *It has, however, to be kept in mind that each coefficient refers to the tendencies present in one rater only* and that a generalization of the results from rater to rater or from our three raters to a larger population of possible raters, could be done only after due consideration of the sampling problem, and hence for our data in only a very limited way.

A second problem involving the "personal equations" of the raters is the following: Is there any relation between degree of insight and tendency to rate subjects by projection or contrast? Sears (16) maintains that subjects lacking insight in one of their own traits tend to project this trait into others, whereas judgments are made in the direction of contrast when there is personal insight; i.e., if a person is aggressive without fully realizing it, he tends to call others aggressive, but if he recognizes this aggressive tendency in himself, then he tends to regard others as submissive.

Considering the small number of raters, a reliable measure of insight is hard to obtain. We have substituted the agreement between self-ratings and ratings obtained from the other three judges as a rough approximation. The agreement with others on one's own personality can be measured in two ways: (*a*) by the rank-order correlations over the nine drive variables ranked according to ratings obtained from others and according to self-ratings; (*b*) by the size of the discrepancies between ratings obtained from others and self-ratings, averaged over the nine drive variables. According to the first criterion, Judges *F* and *G* show good insight (.85 and .73) whereas the correlation between self-ratings and ratings obtained is only slightly positive (.23) for Judge *H*. The same results obtain using the second criterion: the average discrepancy of *F* and *G* are about .67 and .57 units of the rating scale, and that of Judge *H*, .83 units.

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[20] A parallel treatment has been undertaken for a related problem of projection versus contrast with similar results. The problem was: do raters receiving extreme ratings (i.e., ratings on the upper or lower end of the scale) tend to hazard extreme ratings for children. In other words, does the fact of being at an extreme lead to projecting extreme tendencies in others? Again, is it being extreme according to other raters or according to oneself which counts in this respect?

The intensity of presence or absence of certain tendencies in her personality, as judged by others, is projected by Rater *G* into both boys and girls, whom she tends to rate extremely high or low on the same traits for which she has been rated extremely high or low. There is again a tendency in Judge *F* to rate by contrast. That means that the subjects tend to be rated as average for those drives on which the rater herself is extreme, and vice versa.

In agreement with Sears, Judge *F*, who showed high insight, was found above to have a slight tendency to rate by contrast. Rater *H* on the other hand was found to have the tendency toward projection especially when self-ratings were taken as a measure of personality. The case of Rater *G* is somewhat obscured by the fact that she also tends to project (which is not to be expected according to Sears); but this tendency is marked only for girls.

An attempt was also made to analyze the relationship between insight into own personality and the ability to judge the subjects correctly. For lack of a better criterion, the agreement (inter-rater correlation) of each rater with the other two raters was taken as a rough measure of this ability.[21] Rank-order correlations, over the nine drive variables, between this criterion and measures of insight (discrepancies between self-ratings and ratings obtained by the raters) yielded a somewhat confused picture, showing no appreciable or consistent relationship between insight in own personality and ability to rate others in conformity with the consensus of opinion

Similarly, there is no consistent relationship between "insight' and the inclination to venture extreme judgments about the subjects computed in a manner analogous to the previous rank-order correlations. Coefficients around .7 are, however, obtained for the ratings of girls made by Judges *G* and *H*, indicating a tendency on the part of these two judges to give extreme ratings (high or low) on those drive variables on which they disagree most with the other raters regarding their own status.

A third problem is the following: What is the influence of similarities between judges upon their judgments? Does similarity, in terms of received ratings or in terms of self-ratings, imply that ratings given to the subjects will also be similar for the judges in question?

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[21] Facing an analogous problem, Murray uses the agreement between each judge and the revised "conference ratings" as an index of rating ability. Though in the present study conference ratings were also obtained, their correlations have been computed only with the averages of the ratings given by the three judges, which are the basis of all the discussions throughout the subsequent main chapters of this monograph. As a rough substitute, average inter-rater agreement has thus to be used as a criterion for ability in the present comparison.

TABLE 9

RELATION OF SIMILARITY OF RATERS' MOTIVATIONS TO SIMILARITY OF THEIR JUDGMENTS*

		Pairs of raters		
		F, G	*F, H*	*G, H*
Judge rated by Others	Boys	.56	.32	—.36
	Girls	.61	.04	—.06
Judge rated by Self	Boys	.34	.29	.70
	Girls	.55	.20	.40

*The figures in the table are rank-order correlations for each pair of judges, between the following two sets of rankings of the nine drives: (1) according to the extent of inter-rater agreement on each drive; and (2) according to the extent of similarity of the judges themselves on each drive, as determined (*a*) by others' ratings, (*b*) by self-ratings. See text for further explanation.

In Table 9 rank-order correlations pertinent to this problem are presented which are again based on rankings of the nine drives according to two different criteria. One of these criteria refers to the similarities between ratings given by a certain pair of judges as defined by the inter-rater correlations on the various drive variables presented in Table 2. For each of the three possible pairs of raters, the drives are ranked on the basis of this criterion for boys and girls separately. The other criterion refers to similarities in terms of the smallness of the differences between the ratings the judges themselves obtained on the various drive variables. As in the previous considerations two sub-varieties of the ratings obtained are considered separately, namely ratings assigned by others (upper half of the table) and self-ratings (lower half of the table).

The correlations for ratings assigned by others cluster around zero with a slight overweight of positive coefficients. Positive coefficients lying between .5 and .6 for boys and girls are found for the rater pair *F, G*, indicating that they tend to rate subjects more similarly for those variables on which they themselves are more similar, than they do for the remaining drive variables. For the rater pair *G, H*, however, there is a slight opposite tendency. When self-ratings are taken as a basis of similarity between raters, the coefficients show the positive trend more clearly and consistently, indicating that raters tend to rate the children similarly on those drives where they rate themselves as similar.

Thus though there is a slight tendency for raters to judge subjects similarly where they themselves are judged similar, this trend is by no means significant or consistent as far as our raters are concerned.[22]

In the present chapter an attempt was made to throw light upon some of the major subjective factors assumed to influence the raters' judgments. In Section A, interrelationships between drive variables, implied in the ratings given by the various judges, were analyzed. Considerable individual differences were found. In Section B it was shown that on the whole, explicit liking or disliking of the subjects by the raters has little effect on their ratings. In Section C a series of more subtle problems such as projection versus contrast, preference for extreme ratings, conformity with the consensus of opinion, was discussed in relation to the raters' personalities, their insights into their personalities, their similarities and differences, etc. On the whole consistent trends were not found, or were at least obscured by relatively large individual differences among the raters.

It must be acknowledged that there are various subjective factors influencing drive ratings, and that these factors vary from rater to rater, and that they are not readily predictable. Since they are not systematic, they cannot be controlled as such, but will rather have to be averaged out by using large and representative samples of judges. It is by no means to be concluded that the drive-rating technique has no value. As we pointed out in the introduction, the ultimate justification of this technique will have to come from an analysis of its ability to order and predict other personality data.

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[22] The last problem under the heading of "personal equation" with which we were concerned was the following: Do raters who are similar judge each other more or less correctly than they do raters who are less similar to themselves? Wolf and Murray arrive at the following conclusions with respect to this problem: "In marking other judges a judge usually marked best the judge who resembled him and marked worst the judge who least resembled him." The terms "best" and "worst" refer to the degree of correctness, rather than to favorable vs. unfavorable judgments. Contrary to Murray's findings, in our material greater similarity between judges goes with lesser ability of the two judges to judge each other correctly, that is, in agreement with the consensus of opinion. In view of the small number of our raters, however, these findings possess very little significance. They should serve merely as an illustration of the complexity of the situation regarding this problem.

V. INTERRELATIONSHIPS BETWEEN RATINGS ON DRIVES

Having discussed the influence of the "personal equation" on drive ratings, we may now turn to more important considerations in which the "personal equation" has been partly cancelled out by the use of the averaged ratings of the three judges. The present chapter deals with the interrelationships among the nine drives computed on the basis of averaged ratings. The following chapter will deal with *relationships of the averaged drive ratings to other data.*

The intercorrelations are shown in *Table 10.* For each combination of drives there is now only one pair of coefficients (one for boys and one for girls) instead of the three pairs in Table 5.

The coefficients presented in Table 10 range from —.55 to .85. In counting the number of coefficients with a value of .4 or more (the value at or above which the correlations are significantly different from zero) we find that for boys there are 10 such figures out of a total of 36, and all of them positive. For girls there are 11 positive relationships greater than .4, but in addition we find four coefficients exceeding —.4 in the negative direction.

Only a little more than one-third of the total number of coefficients in Table 10 are significantly different from zero. This seems to indicate that the various drive variables tap several different and statistically independent aspects of personality.[23] As we will discuss below in greater detail, some of the drives may be closely related, or may be tied together by halo effects. But we can now be assured by the fewness of significant correlations, that the relationships of any such clusters to each other and to the remaining drive variables are free from halo effects. The problems of what sets of drives should be regarded as "operational unities" (23), and what drives should be regarded as separate variables, will be discussed later in this chapter. A more conclusive answer to these questions can be attempted only after the relationships of each of the variables to other data have been studied.

To come back to the question of sex differences regarding the degree of relationship among the drive variables: the fact that these interrelationships tend to be slightly greater for girls than for boys

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[23] The relative unreliability of our measures requires caution in making statements about the actual relationship between them.

TABLE 10

Raw Inter-Correlations of Drives from Averages of Ratings

		Soc. Ties	Achieve.	Recog.	Abase.	Aggres.	Succor.	Control	Escape
Autonomy	Boys	—.27	—.19	—.24	.34	.25	—.32	.22	.15
	Girls	—.06	.34	.33	.10	.49	—.22	.51	.34
Social Ties	Boys		.23	.76	—.03	.48	.37	.49	.31
	Girls		—.26	.53	.26	.22	.44	.16	.46
Achievement	Boys			.51	—.28	—.08	.01	.34	—.38
	Girls			.31	—.24	.09	—.47	.37	—.20
Recognition	Boys				—.19	.53	.40	.67	.35
	Girls				—.48	.71	.09	.85	.58
Abasement	Boys					.02	.36	—.32	.12
	Girls					—.54	.10	—.55	—.26
Aggression	Boys						.17	.77	.82
	Girls						.18	.79	.70
Succorance	Boys							—.12	.33
	Girls							.06	.42
Control	Boys								.48
	Girls								.52
Escape	Boys								
	Girls								

has already been presented and discussed in Chapter IV. It finds further support when the symbols a and *a* in Figure 1 are examined. These symbols indicate the closeness of relationship between two drive variables in terms of their patterns of relationship with the remaining variables. They thus yield indirectly what is represented in terms of direct correlations in Table 10. Since the symbols in Figure 1 are based on clusterings of correlation profiles ascertained by an approximative procedure, not too much weight should be assigned to them. However rough this criterion may be, the greater clustering for girls than for boys is quite striking. For boys there are only four "*a*" 's; for girls, there are 11, four of them negative (italicized), and in addition there are three more symbols indicating close but less marked relationships. On the whole the location of these symbols agrees well with that of high correlation coefficients in Table 10.

To go into greater detail, the strongest ties seen in Table 10 as well as in Figure 1 are found between Aggression on the one hand, and Control and Escape on the other. Coefficients for both sexes range from .70 to .82. The relationship between Control and Escape is likewise marked (around .5 for both boys and girls). Recognition seems also to be a member of this cluster, but to a less marked degree *and more for girls than for boys; its correlations* range *(for boys and* girls) from .35 to .85. All the remaining significant ties in Table 10 are limited to one of the sexes.

Considering the fact that drive for Control refers to what also has been described as dominance, its close relationship with Aggression is to be expected. The question may be raised of the usefulness of including them both in our list. Aside from the fact that little harm can be done by duplication, we may justify their separate use on the empirical grounds that there are interesting differences between these two variables in their relationships to manifest behavior (see Chapters VI and VII). On the whole, Control tends to show closer relationship with behavioral manifestations indicating adjustment, whereas Aggression is tied more closely to some maladjusted forms of behavior. In Table 10 the same tendency becomes evident when correlations of Achievement with Aggression and with Control are compared. For both sexes the socially approved drive for

Achievement correlates about zero with Aggression, but about .35 with Control.

The relationship of Recognition to Aggression and Control brings in a third variable whose differentiation from the other two will have to be considered. It appears that in terms of behavioral manifestations, Recognition holds its own when compared to Aggression, and in the same way as Control, but even more clearly.

The fact that Aggression shows a high positive relationship with Escape may seem surprising at first glance. But it does so only as long as we conceive of Aggression and Escape as behavioral manifestations, not as underlying forms of motivation. On the underlying levels of dynamics, aggression may well be a compensation for, and thus caused by, a tendency to escape; or, vice versa, hostility may lead to difficulties or guilt feelings and therefore to escape. It has become a common saying that insecurity will lead to aggressiveness. Thus the drive for Escape may well correlate with the drive for Aggression. This would be in line with the psychoanalytic assumption that both escape and aggression are forms of infantile regression.

The question, pertinent to all our material, may again be raised explicitly: How much does the fact that our subjects are adolescents contribute to our results? It may well be that the relationship between Aggression and Escape is more marked in adolescents than it is in adults. The latter have had more time to discard one in favor of the other.

Some of the drive variables may now be discussed in greater detail in terms of their relationships to the other drive variables. Special emphasis will be laid upon sex differences.

For "Autonomy," correlations with other drives seldom reach .5. This may partly be due to the fact that the reliability of this variable is very low, by far the lowest of all the drive variables. There are, however, some interesting sex differences. There are significantly higher positive relationships for girls than for boys with Achievement and Recognition. The linear differences (if consideration of such differences is permissible as a first approximation) between the correlation coefficients of boys and girls is .53 and .57 respectively.[24] There is a tendency in the same direction, though below the level of significance, for Aggression and Control (striving for dominance). It seems quite plausible that Autonomy, being less appropriate and adjusted for girls than for boys in our society, should have higher relationships to more active masculine tendencies, such as those mentioned in girls.

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[24] Differences can be considered significant from around .4 upwards.

A quite reversed picture is given by our second variable, Social Ties. Here there is a significantly higher positive relationship in boys than in girls for Achievement and Recognition, and a difference approaching significance for Aggression and Control. For Achievement, the values are not high, .23 and —.26 respectively, but *their algebraic difference is significant*, reaching almost .5. In Recognition, boys reach the maximum value for correlations with Social Ties, .76. The girls are left significantly behind, but they too show a positive tendency, .33. The trend in question is less clear for Aggression and Control, but again the coefficients are higher for boys than for girls. In girls, Social Ties may be an end in itself, showing correlations of more than .4 with only the "passive" tendencies, Succorance and Escape; whereas in boys, Social Ties seems to be connected with a number of other active strivings. The close relationship between Social Ties and Recognition in our group may mean a subordination of both these strivings to some more urgent goals such as the gaining of status. The urgency of these goals may again be a function of age; the relationship between Social Ties and Recognition may be less strong in adult life.[25]

The drive for *Achievement shows relatively little relationship* with the other drive variables. Its closest affiliation is with Recognition. In the way of sex differences, there is a significantly greater tendency for girls than for boys toward a positive relationship with Autonomy. Furthermore, Achievement is unrelated to Succorance in boys, yet these two drives are incompatible, to the extent of almost —.5, in girls. Apparently boys will be motivated toward Achievement independently of how they stand in Autonomy or Succorance.

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[25] It is also quite possible that we are dealing with the effects of cultural factors. The relationship between Social Ties and Recognition might not be present in, for example, a rural group, and in a New England community with different success standards, Achievement might be found to be more strongly related to some of the other drives than we have found to be the case in our group.

Girls, on the other hand, will more likely be motivated toward Achievement if there is some striving for independence (Autonomy); girls with a striving for dependency (Succorance) are less likely to seek Achievement.

Of the remaining variables we shall consider chiefly Aggression. Its close relationships with Control and Escape for both boys and girls have already been discussed. Sex differences are conspicuous only for Abasement, which correlates zero with Aggression in boys, and —.54 with Aggression in girls. This may be a reflection of the fact that girls with "masochistic" tendencies can often work them out in our society without developing hostile tendencies. As will be shown in Chapter VIII, girls with high ratings on the drive for Abasement are either insecure or truly altruistic. The latter solution excludes Aggression. In the former case Aggression may or may not be present. The resulting correlation may be expected to be *moderately high on the negative* side, which is borne out by the coefficient just presented. In boys, on the other hand, Abasement apparently goes as often as not with Aggression, possibly in a compensatory fashion when it does.

Even in the case of boys, however, one would have expected the correlation between Abasement and Aggression to be considerably on the negative side if these two terms had been defined on the manifest rather than on the motivational level.[20] The fact that this is not the case may be taken as an indication that the raters actually did rate something which stands behind manifest behavior. In the same way, we may attempt to explain the correlations between Aggression and Succorance, which are, for both boys and girls, close to zero but slightly positive. What we call overt aggressive and succorant behavior ought to correlate negatively. But as drives they may well be really independent, or aggression may even spring from a maladjustment resulting from succorance.

It will by no means be forgotten that the judges may have been influenced in their ratings by theories or by accumulated experiences, either of an implicit or of an explicit character. However, the rapidity with which the ratings were made, and the form of the rating scale, created conditions under which notions about general relationships between drives could have had only a minimal effect. Moreover, it may reasonably be said that any theoretical prepossessions which may have been held by the raters were by no means as detailed as the relationships found by means of statistical analyses of the ratings.

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[20] The idea of the mutual exclusiveness of abased behavior and aggressive behavior finds its clearest expression in the construction of rating scales using aggression and submission as the opposite ends of a linear scale.

Thus far, our argument concerning the subjective or objective basis of the notions of drives and their interrelationships has been approached only in the fashion of an *argumentum ad hominem.* The fact that their interrelationships corroborate general clinical insight or psychoanalytic theory cannot alone be taken as a final proof that drive ratings hit something focal in the dynamic personality structure of our subjects. We must now turn to a statistical analysis of the relations of rated drives to manifest behavior, as well as to other, more independent, sources of information. The interrelationships between drive variables can be understood in only a very fragmentary fashion before these further references have been made.

VI. RELATIONSHIP OF RATED DRIVES TO BEHAVIOR IN SOCIAL SITUATIONS

A. Comparison of the Two Sets of Data

In order to link the drive ratings to primary (i.e., directly observable) behavior data, correlations were computed between these ratings and observations of manifest behavior. These observations had been made previously in a series of social situations arranged for observational purposes, and centering around the activities of the adolescent group in the Clubhouse. The situations comprised play, dancing, and various types of social gatherings (10).

In these the chief emphasis was put on observation of overt behavior as limited, in most cases, to the specific social situation.[27] Some of these ratings pertained to such concrete aspects of behavior as grooming activities, or the frequency of actually executed social contacts. Other items were more abstract and interpretative of emotional adjustment (e.g., tenseness, selfishness). However, all the items have the common characteristic of emphasizing the specific response as displayed in social situations.

One of the consequences of such an approach is that inhibited tendencies do not find representation. Only the gross behavior is recorded, not always differentiating between genuine expression and social technique.[28] The advantage of the behavior ratings, however, is their relative objectivity in describing, prior to extensive interpretation, the actual behavior and techniques employed by the individual. Thus they furnish a part of the necessary frame of reference for hypotheses about the motivational personality.

Drive ratings and behavior ratings are related in the sense that both are based on the same source, behavior, though in different ways. Our problem is to determine the particular relationships between the two. These relationships may be interpreted as being between inferred drives on the one hand, and overt manifestations on the other. As an alternative interpretation, our results could be taken as indications of the behavioral cues which the raters, as a group, used for their inferences, and which thus in a logical sense constitute their conceptions of the drives. This problem of the "locus" of the correlations will be discussed in greater detail below.

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[27] In the following discussion ratings based on behavior in social situations will be referred to as behavior items and as situation items. These terms are used synonymously.

[28] The qualitative comments which accompanied the ratings often made this *differentiation possible. But this was not necessarily reflected in the final* score.

The social situation ratings[29] are based on the averaged ratings of four judges, two of whom later participated in our drive ratings. This raises the objection that personal bias may have contributed to the relationships found between drive and behavior ratings. The influence of personal bias is reduced by the following facts: (*a*) the drive ratings did not include judgments of two of the judges who functioned in the social situation ratings; (*b*) there was a lag of two years between assigning situation ratings and drive ratings. The situation ratings were made when the subjects were in the high eleventh and low twelfth grades. As we mentioned above, the drive ratings were made after the subjects had left the study. (*c*) They were made with the explicit instructions to use behavior as a basis for interpretation rather than to take it at its face value; (*d*) the pattern of our results suggests their general validity and makes personal bias as a basis highly improbable. The strongest argument in favor of the objective basis of drive ratings is the demonstration of their predictive value for reactions other than those used for inferring the drive ratings. This will be discussed in IX and X.

Of the 40 social situation items available, 33 were selected in order to avoid unnecessary detail or duplication.[30] They are listed below and in the top part of Table 12.[31] Their order is the same as the order in which the ratings were made. Excerpts or abbreviated adaptations from the descriptions given the raters are presented.

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[29] For a thorough discussion of the social situation ratings, their reliabilities, halo effect, etc. see Frances Burks Newman, *Charting Adolescent Behavior: An Evaluation of Observational Records in a Longitudinal Study*, monograph in preparation.

[30] In a number of instances, separate situational ratings were available for behavior of the subject with boys and with girls. For the sake of simplicity only those ratings were used which refer to the subject's own sex. The list of the items in question is: "social participation," "social self-confidence," "attention-seeking," "affectation," "social stimulus value," "self-assertion," "talkativeness." For "popularity" both ratings were considered in Table 12. A number of special items clearly recognizable in Table 12 refer to attitudes toward the opposite sex only.

[31] As compared with the original form of the scale, the direction of some variables has been changed in order to avoid too many negative correlations for convenience of discussion. For instance, the variable which we call "tenseness" was originally termed "freedom from tenseness," etc.

Attractive Appearance—Attractiveness and pleasantness of appearance, including coloring, features, proportion of body, carriage, cleanliness, facial expression, becoming clothes, distribution of fat.

Grooming Activity—Obviously spends a great deal of time in grooming self. Frequently arranges or combs hair, brushes off clothes, puts on make-up.

Energy Output—Overtly active practically all the time, including gross movements and aggressive contacts with physical environment; eager, animated, bodily movements.

Interest in Opposite Sex—Continually initiates contacts with and takes every opportunity to attract attention of members of opposite sex, for activities in which sexes are mixed.

Reference to Opposite Sex—When none of opposite sex are present: frequently talks about members of opposite sex; tries out techniques usually successful with, or in anticipation of future contacts with opposite sex.

Social Participation—Takes every opportunity for social contact allowed by the nature of the situation. Continually directs attention toward others, talks to them and participates in activities with them.

Seeking of Adult Company—Seeks out adult in preference to children in a group. Hangs around adults making frequent bids for attention. Identifies self with adults. Very cordial to adults.

Resistance to Authority—Deliberately breaks rules. Refuses to comply with requests of person in charge. Subtly resists authority; evasive, sly, two-faced, smooth, in contrast to: Eager to comply with adults' wishes; anticipates what adults might want; asks adult assistance in enforcing regulations; extremely suggestible with adults.

Social Self-Confidence—Very assured behavior with both adults and children. Takes failure in matter-of-fact way. Invites new situations requiring poise and confidence.

Attention-Seeking—Constantly seeks to put self in a conspicuous position; bluffing, showing off. Exerts strenuous efforts to gain recognition of associates.

Affectation—Markedly affected speech, mannerisms, or gestures; simulation of modesty or wistfulness.

Social Stimulus Value—Frequently stimulates others by his presence. Attracts and keeps their attention.

Popularity with Same Sex—Generally approved and admired by others. Efforts repeatedly made by others to attract his attention. A preferred partner in activities; his company sought by many.

Popularity with Opposite Sex—(Definition same as above.)

Self-Assertion—Monopolizes conversation with, or interferes with activities of others. Continually giving directions and ordering others about.

Sensitivity and Dependence on Approval—Excessively concerned about the sort of impression he makes on his associates. Very sensitive and easily "hurt". Reacts strongly to praise or blame. Constantly leaning on others for approval of his actions, or help in his decisions.

Leadership—Highly successful in influencing the group either directly or by indirect suggestion. Competent in organizing and handling group activities. Comments or suggestions welcomed by the group and readily accepted.

Group Interest vs. Self Interest—Quickly adapts himself and buoyantly carries the load of enthusiasm for group interests and activities, or, quickly adapts and devotes himself unreservedly to the interests of the group. Enthusiastically encourages activities in which most of the group are interested.

Talkativeness as contrasted with Quiet.

Dissatisfied as contrasted with Content.

Exuberant as contrasted with Gloomy.

Excitedness as contrasted with Calmness.

Irritability as contrasted with Good-naturedness.

Tenseness as contrasted with Relaxed.

Impulsiveness as contrasted with Deliberative.

Anxiety as contrasted with Carefree.

Frequent Mood Swings as contrasted with Constancy of Mood.

Selfishness as contrasted with Coöperative.

Irresponsible as contrasted with Responsible.

Exploitive, demanding of others as contrasted with non-exploitive, undemanding.

Well Adjusted Socially as contrasted with Poorly Adjusted Socially.

Predominantly Oriented toward Opposite Sex as contrasted with predominantly Oriented toward Same Sex.

Smooth Social Functioning, i.e., without emotional interference as contrasted with Blocked in Social Situations, frequent emotional interference.

The reliabilities of the 33 behavior items range from .37 to .77 unraised, or .54 to .87 raised. In the tables and graphs of this chapter only eight of the nine drives are shown. No computations were made for Autonomy because of its low inter-rater agreement discussed in Chapter III.

B. RELATIONSHIPS OF RATED DRIVES TO SITUATION RATINGS TAKEN AS A GROUP

The purpose of Table 11 is to indicate the similarity between the single drives in terms of their relationships to the behavior ratings as a whole. This can be visualized from the left part of Table 11 by following rows and columns in both directions away from the diagonal.

Table 11 and its explanation are chiefly of methodological interest. The drive variables are arranged in such an order that the average differences between corresponding correlation coefficients (boys and girls taken together) are at a minimum for adjacent drives. The average differences shown in the left part of the table are computed in the following fashion, according to the squared r method: all the coefficients shown in Table 12 are first squared but the squares are assigned the same sign, positive or negative, which the original coefficient possessed. Algebraic averages are then computed for corresponding values of boys and girls. The next step consists in the computation of all the algebraic differences corresponding to the 28 possible intercombinations of the eight drive variables, for each of the 33 situation items. The signs of all these differences are then discarded, and they are averaged over all the 33 items for each of the combinations of drives. In the table the square roots of these 28 averages are shown. It can be seen that the rearrangement of the sequence of drives can be made with a satisfactory degree of consistency.

The right part of Table 11 shows the average correlations of each drive variable with 33 situation items, giving two values for each drive, one with signs taken into consideration, the other with signs discarded.[32]

According to both of these criteria, the relationships are rather close for the first five drives. They are in the neighborhood of .40 to .45 with very little difference between absolute and algebraic averages, indicating almost complete absence of negative correlations. There is a break from here to the last three drives, Succorance,

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[32] These [illegible]erages are also based on the squared r's rather than upon the numerical[illegible]ues; signs are, however, retained in their original value except for the l[illegible]tep of computation leading to the results presented in the left part as w[illegible]s in the first column of the right part of the table.

TABLE 11

REARRANGEMENT OF RATED DRIVES BASED ON THEIR RELATIONSHIPS TO 33 SOCIAL SITUATIONAL ITEMS, BOYS AND GIRLS TAKEN TOGETHER

	Absolute Averages, for the 33 items, of algebraic differences between correlations for each combination of drives.								Average correlations with the 33 items.	
Rated drives	Soc. Ties	Rec.	Cont.	Agg.	Esc	Suc.	Ach.	Abase.	For absolute values	With signs respected
Social Ties		.24	.27	.35	.35	.38	.42	.47	.39	.39
Recognition	.24		.22	.31	.32	.39	.44	.50	.44	.44
Control	.27	.22		.28	.29	.40	.44	.51	.44	.44
Aggression	.35	.31	.28		.26	.43	.49	.54	.47	.46
Escape	.35	.32	.29	.26		.35	.43	.47	.40	.39
Succorance	.38	.39	.40	.43	.35		.31	.52	.24	.19
Achievement	.42	.44	.44	.49	.43	.31		.31	.21	.09
Abasement	.47	.50	.51	.54	.47	.52	.31		.26	—.23

Achievement, and Abasement, with absolute averages of around .20 to .25. In the case of Achievement the algebraic average drops to about .1, and in the case of Abasement it becomes negative, —.23, indicating the frequent occurrence of negative correlations with these two drive variables.

In fact the correlations between Abasement and the situation ratings are inversely related to the corresponding correlations between the first five drives and the situation ratings. This negative relation is not surprising when we consider that Aggression and Recognition motivate, among other manifestations, overt social activities, whereas Abasement as a motive is apt to inhibit them.

The data thus suggest that behavior in social situations reflects the first five drives. In contrast to this, the last three variables seem on the whole to show less clear relationships to social behavior. It will be shown in Chapter VIII, however, that they are tied to certain general traits such as "introversion" and "maturity." They also show close relationships to the Adjustment Inventory, whereas the first five drives do not (see Chapter IX). Thus in no sense can the last three drives, Succorance, Achievement, and Abasement, be considered less important than the first five, whether we consider them as constructs facilitating the organization of data, or as dynamic realities.

By and large, the sequence of the eight drive items described in Table 11 is rather in agreement with what has been discussed in greater detail in Chapter V in connection with the direct interrelations of drives. In going back to Table 10 it can be seen that combinations of drives adjacent to one another in Table 11 tend to show the highest direct correlation. For boys and girls taken together, the relationship between Social Ties and Recognition is better than .55, and for the subsequent adjacent pairs of Recognition and Control, Control and Aggression, Aggression and Escape, it is between .75 and .80. Further down in the list of the eight drive variables rearranged in Table 11 the relationships are not as close when viewed in the light of Table 10, yet even there they are consistent enough to justify the proposed reorganization.

A further similarity between the first five drives is given by the fact that they are those with the highest inter-rater agreements as shown in Table 2, with averages from .45 up, unraised, and from

TABLE 12
Raw Correlations between Rated Drives and Behavior Observed in Social Situations

		Attractive Appearance	Grooming Activity	Energy Output	Interest in Oppos. Sex	Reference to Oppos. Sex	Social Participation	Seeking of Adult Comp.	Resistance to Authority	Social Self-Confidence	Attention-Seeking	Affectation	Social Stimulus Value	Popularity (Same Sex)	Popularity (Oppos. Sex)	Self-Assertion	Dependence on Approval
Social Ties	Boys	.06	.25	.60	.56	.58	.50	.34	.13	.50	.66	.55	.48	.26	.46	.64	.62
	Girls	—.16	—.01	.30	.32	.31	.51	.45	—.09	.39	.51	.30	.31	.16	.20	.40	.42
Recognition	Boys	.20	.38	.50	.43	59	.45	.49	—.06	.53	.59	.50	.48	.32	.47	.62	.66
	Girls	.20	.42	.20	.51	.51	.45	.23	.44	.56	.66	.70	.45	.29	.45	.62	.55
Control	Boys	.11	.22	.56	.30	.49	.62	.41	.17	.57	.83	.53	.61	.42	.40	.70	.58
	Girls	.15	.36	.12	.39	.39	.35	.23	.47	.41	.63	.69	.31	.17	.28	.66	.37
Aggression	Boys	—.10	.14	.42	.20	.49	.48	.20	.36	.29	.78	.76	.46	.11	.17	.64	.62
	Girls	.12	.36	.13	.51	.54	.39	.11	.53	.45	.70	.77	.41	.22	.41	.68	.39
Escape	Boys	—.05	.14	.24	—.15	.38	.32	—.08	.39	.12	.60	.63	.29	.03	.11	.46	.45
	Girls	.00	.37	.00	.41	.49	.41	.32	.32	.31	.69	.77	.31	.04	.20	.54	.52
Succorance	Boys	.04	.19	.00	.10	.21	—.01	.13	—.16	—.05	.17	.29	—.04	—.16	—.06	.05	.31
	Girls	—.17	—.01	.04	.13	.12	.29	.26	.14	.15	.45	.41	.05	—.19	—.20	.57	.38
Achievement	Boys	.24	29	.23	.21	.15	.08	.51	—.40	.37	—.01	—.07	.18	.28	.34	.18	—.13
	Girls	.33	—.12	.16	—.12	—.23	—.10	—.13	.18	.17	—.14	—.11	.14	.30	.06	.02	—.39
Abasement	Boys	—.35	—.41	—.09	—.15	—.18	—.21	—.08	.11	—.52	—.13	.00	—.25	—.28	—.36	—.17	—.16
	Girls	—.42	—.54	.01	—.25	—.33	—.05	.15	—.52	—.32	—.28	—.46	—.31	—.37	—.39	—.28	—.07

TABLE 12 (*continued*)

		Leadership	Group Interest	Talkativeness	Dissatisfied*	Exuberance	Excitedness*	Irritability*	Tenseness*	Impulsiveness*	Anxiety*	Frequent Mood Swings*	Selfishness*	Irresponsible*	Exploitiveness	Social Adjustment	Orient. toward Oppos. Sex	Smooth Soc. Functioning
Social Ties	Boys	.39	.41	.65	—.06	.54	.68	.05	.54	.60	—.04	.39	.10	.21	.66	.23	.59	.28
	Girls	.28	.19	.50	.22	.20	.49	.04	.25	.54	.15	.29	.01	.10	.37	.16	.36	.23
Recognition	Boys	.46	.39	.65	—.07	.49	.58	.07	.46	.50	—.07	.35	.06	.08	.61	.23	.50	.35
	Girls	.38	—.14	.45	.25	.05	.49	.52	.30	.56	.13	.55	.45	.45	.66	.07	.46	.13
Control	Boys	.60	.51	.75	—.19	.57	.67	.01	.26	.58	—.24	.29	.12	.28	.70	.29	.35	.39
	Girls	.29	—.28	.37	.40	—.11	.42	.62	.41	.50	.29	.64	.53	.50	.69	—.15	.33	—.06
Aggression	Boys	.32	.18	.64	.20	.30	.70	.41	.48	.68	.12	.61	.51	.65	.79	—.09	.24	.01
	Girls	.36	—.35	.48	.32	.01	.42	.74	.35	.63	.20	.71	.66	.62	.80	—.10	.44	.07
Escape	Boys	.16	.02	.42	.29	.18	.57	.42	.36	.57	.14	.55	.57	.70	.65	—.18	.21	—.06
	Girls	.19	—.28	.49	.39	—.02	.49	.56	.23	.60	.29	.50	.53	.57	.73	—.16	.40	.06
Succorance	Boys	—.15	—.08	.06	.22	—.05	.20	.20	.35	.11	.28	.23	.16	.11	.17	—.26	.18	—.24
	Girls	.03	—.26	.40	.43	—.15	.31	.43	.17	.42	.31	.33	.42	.39	.49	—.26	.05	—.03
Achievement	Boys	.27	.30	.19	—.30	.31	.08	—.36	.11	—.01	—.23	—.25	—.44	—.48	.00	.37	.16	.41
	Girls	.18	.05	—.19	—.05	.10	—.06	.07	.11	—.10	—.04	.02	—.03	—.22	—.13	.08	—.20	—.06
Abasement	Boys	—.23	—.20	—.24	.46	—.33	—.04	.23	.21	.03	.36	.19	.00	.07	—.13	—.34	— 26	—.42
	Girls	—.27	.25	—.06	.17	—.11	.03	—.55	.09	—.15	.17	—.20	—.43	—.32	—.46	—.20	—.32	—.19

.7 raised. A differentiation of these five drives in terms of their relations to behavior will be given in the following section.

C. RELATIONSHIPS OF SINGLE DRIVES TO BEHAVIOR ITEMS

Before showing the more complex relationships between rated drives and behavior observations, specific correlation trends will be discussed. The data are presented in Table 12 showing raw correlation coefficients for boys and girls separately, for the 264 combinations between the eight drive variables and the thirty-three situation items.

Of our group of 49 boys and 46 girls which had been rated on drives, 44 boys and 38 girls enter this comparison. The omissions are due to the fact that some of the children were not rated on the situation material. As a rough estimate (varying with the size of the correlations) differences of .4 between correlation coefficients may be regarded as significant.

A glance at Table 12 shows that the profiles for boys and girls are rather similar. In the subsequent discussion, there will be emphasis on sex differences whenever they do appear.

Detailed discussion of all coefficients shown in Table 12 cannot be attempted. The discussion will concentrate on selected variables and will summarize briefly the rest of the material.[53]

We select first the ratings on Recognition. The drive for Recognition is one of the first five variables mentioned as showing relatively high average correlations with the behavior ratings. Examining the second row of Table 12 item by item, we find some interesting relationships with particular situation ratings as well as some interesting sex differences.

Recognition shows relatively little relationship with "attractive appearance" for both boys and girls, but somewhat more with "grooming activity" (about .4). In "energy output" boys' correlations are higher than the girls' (.5 vs. .2). The difference is not quite significant, but general experience and further correlations to be mentioned suggest that the drive for Recognition is more openly displayed in boys whereas girls more commonly show a tendency to hide it. "Interest in the opposite sex" and "reference to the opposite sex" correlate about .5 with Recognition in both boys and girls (which may or may not be a specific feature of adolescence) and so does "social participation." "Seeking of adult company" is slightly higher in boys than in girls who rate high on Recognition, and "resistance to authority" is significantly higher in girls than in boys. Values of from .45 to .70 for both boys and girls are found for the next four items: "Social self-confidence," "attention-seeking," "affectation," and "social stimulus value." "Popularity with the same sex" correlates about .3, "popularity with the opposite sex" about .45 with Recognition for both boys and girls. For "self-assertion" the relationship is rather close, .62 for both boys and girls. In "dependence on approval" boys striving for Recognition are higher than girls to an extent approaching significance (.66 vs. .35); again boys more often display their sensitivity and dependence on approval whereas the girls tend to inhibit their drive for Recognition. Correlations with "leadership" are about .4. A highly significant sex difference of more than .5 is shown for "group interest," with boys exhibiting much more "group interest" than girls. "Talkativeness" averages about .55.

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[53] To distinguish between the two types of data, drives will be capitalized as was done in the previous chapters, and social items will be referred to in quotation marks.

Most of the behavior items discussed thus far such as "energy output," "social participation," "self-confidence" (defined as inviting new situations), "self-assertion" (bossiness), "leadership," may be conveniently labelled by the phrase "overt social activity," indicating a direct expression of the drive for Recognition, whether this expression is more or less adjusted. On the whole, correlations of Recognition with these items are rather high. Among the remaining items, "exuberance" and "orientation toward opposite sex" fall in the same category.

With the exception of the items just mentioned and the remaining two of the last three situation items, the subsequent list of behavior items may be comprehensively labelled "emotional maladjustment." This category comprises items like "irritability," "tenseness," "frequency of mood swings," "selfishness," etc. Though Recognition also shows relationships to the items on this second part of the list, these relationships are more uneven than the first category and are generally more marked for girls than for boys.

For example, girls striving for Recognition are somewhat more likely to be "dissatisfied" than boys striving for Recognition. For boys the correlation with "exuberance," which belongs to the first category of overt expressiveness is almost .5 whereas for girls there is practically no relationship. This again points, as did the third item, "energy output" toward the greater overtness of the striving for Recognition in boys than in girls. The relationship with "excitedness" is about .54. There is a significant sex difference in the next item "irritability," as well as in "selfishness" and "lack of responsibility." Girls striving for Recognition show a marked tendency of about .5 to be "irritable," "selfish," and "irresponsible." All of these items indicate emotional maladjustment in girls whereas these relationships are practically absent in boys. There is some positive relationship for both sexes with "tenseness" and with "impulsiveness," no relationship with "anxiety," and a relationship with the tendency toward "frequent mood swings" which is higher for girls than for boys, though not significantly so. There is a high correlation, between .6 and .7, of Recognition with "exploitiveness" in both boys and girls.

The relationship with "social adjustment" is negligible and so is the one with the last item, "smooth social functioning," at least as far as girls are concerned. The next to last item, "orientation toward the opposite sex," is very similar in content to the fourth and fifth items of the list and belongs to the category of overt social activity. Like these, it shows a correlation with the striving for Recognition of about .5 for both sexes.

The behavior profile of Recognition will now be compared with the profiles of the other four drive variables which have already been found to be closely related with regard to behavioral manifestations. These are, namely: Social Ties, Control, Aggression, and Escape. In discussing similarities and differences among these five drives, the distinction made between overtly expressive social behavior and emotional maladjustment will be kept in mind, and special attention will again be paid to sex differences.

Let us start with Aggression. As does Recognition, Aggression correlates positively with the items in the category "overt social activity" yet these correlations are generally not as high as for Recognition. It should be noted that there is a slight and consistent relationship between Aggression and such items of positive social success as "leadership," or "social stimulus value." This is the more remarkable as the defining remarks given to the raters for the drive for Aggression (see Chapter II) stress the maladjusted angle. Apparently there was more generality underlying the actual handling of the drive category Aggression by the raters than was explicitly suggested in the definition. Such broadness is in agreement with psychoanalytic and other assumptions regarding aggression as an important component of every active type of behavior (Alexander,[31] Murphy). On the other hand, according to psychoanalysis a high degree of hostility will be found in every maladjusted form of behavior (e.g., neurosis). Correspondingly Aggression shows generally higher correlations than Recognition with the various behavioral forms of maladjustment. This can best be seen by comparing the two drives in the right half of Table 12.

On the whole the two sexes show less differences on Aggression than on Recognition, but there is again a slight tendency for girls rated high on Aggression to be more emotionally maladjusted than for boys (e.g., there is less "group interest" but more "irritability" and also more "selfishness"). The highest point in the behavior profile of the drive for Aggression is "exploitiveness," showing the highest correlation of the whole table, .8 for both boys and girls. One may partially account for this by the fact that exploitiveness is one of the less concrete items in the behavior list. It refers to a result of behavior rather than to a specific manifestation and thus is more comparable to some of the general traits to be discussed in Chapter VIII. Other high points are "frequent mood swings," "affectation," and "attention-seeking," with little sex differences for any of these items. The only sizeable negative relationship is with "group interest" in girls. As can be seen from Table 11, Aggression is generally the most expressive of all the drives in the sense of being displayed in social situations, with an average correlation for all the 33 situation items of .47.

The behavior profile of Escape is very similar to that of Aggression. Among the differences, none of which is quite significant, we mention only the smaller relationships of "energy output" for both sexes, and "interest in the opposite sex" for boys. For "interest in opposite sex" there is a significant difference between boys and girls. For girls, but not for boys, there is a clear relationship between Escape and "interest in opposite sex." There is a similar relationship of the sexes regarding "seeking of adult company," whereas both aggressive boys and aggressive girls have a rather indifferent relationship, as a group, with this item. Generally speaking, the *relationships between Escape and "overt social activity"* are slightly but consistently higher for girls than for boys. On the side of emotional maladjustment sex differences are negligible; the general trend is rather similar to Aggression.

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[31] Alexander, F. *The Psychoanalysis of the Total Personality.*

The last two of the group of five drives, Social Ties and Control, will now be considered briefly. The general pattern of ups and downs of Control is more similar to Aggression than to the other drives. However, like Social Ties and Recognition, the left part of its profile is slightly but consistently higher than that of Aggression. The items "social participation," "social stimulus value," "popularity," "leadership," and "group interest," show their highest correlations with Control for boys. The differences between some of these correlations and the corresponding ones for Aggression approach significance. On the other hand with respect to emotional maladjustment the profile for Control is closer to zero than is that for Aggression, a feature which Control again shares with Recognition and with Social Ties. This is especially true for the boys with respect to Control and Recognition, whereas the girls' profiles tend to be almost as high on these as on Aggression. The sex differences in "group interest" reaches a maximum in the case of Control: .51 versus —.28. This is the maximum sex difference that occurs in Table 12.

Thus, whereas Control shows more resemblance to Aggression in its specific pattern, it is more similar to Recognition with respect to the more general trend of "overt activity" versus "emotional maladjustment." This is also brought out in Table 11 by the fact that the lowest average discrepancy, .22, between the behavioral representations of any two drives, is found for Recognition and Control, whereas it is .28 for Control and Aggression.

It may be fruitful to make a conceptual distinction between the latter two drive variables in view of the important differences in their manifestations. Whether or not such a distinction should be retained for Control and Recognition is questionable from the point of view of our material. However, such a distinction can do little harm, since we do not assume that these motivational tendencies are independent "factors," but rather use them as guiding concepts with no claim toward orthogonality.

The distinction between Recognition and Social Ties seems in any case more justified, as far as behavioral manifestations are concerned, than the distinction between Recognition and Control. There are, for example, clear differences between the former two drives with respect to sex differences in their behavioral manifestations, whereas there are very little differences in this respect between Recognition and Control. Social Ties shows consistently higher relationships with behavior items for boys than for girls, whereas this is not the case with either Recognition or Control. One conspicuous difference is in "resistance to authority," which is higher for girls than for boys in the case of Recognition, but higher for boys than for girls in the case of Social Ties. In general it may be stated that for boys, Social Ties finds expression in greater overt social activity, but also greater emotional maladjustment than for girls. Recognition finds expression for both sexes about equally, in overt social activity, but is more closely related to emotional maladjustment in girls than in boys.

Generally, the differences between correlation profiles increase as we proceed from the upper to the lower portions of the table, in accordance with the way in which the list of drive variables has been rearranged (see Section B of this chapter, Table 11, and also Section D). Relatively high coefficients are found between the adjusted behavior items and Social Ties, Recognition, and Control, and between the maladjusted items and Aggression and Escape. For contrast, the last variable in the list of drives, Abasement, will now be discussed.

The correlations of the rated drive for Abasement with situation items are generally low and often negative. Yet these coefficients illustrate some of the less obvious or even unexpected relationships which are so difficult to explain unless certain psychoanalytic concepts are resorted to. Abasement shows a negative correlation, somewhat less than —.4, for boys and girls averaged, with "attractive appearance." With the next item "grooming activity" the correlation is even higher in the negative direction, nearly —.5 for boys and girls averaged. This somewhat surprising finding suggests that neglect of grooming may be primarily the expression of a masochistic tendency, and the lack of attractive appearance a result rather than the cause of masochism.

Among the further correlates of Abasement we mention a negative relationship for girls, but not boys, with "resistance to authority" and with "affectation." Likewise, "selfishness" correlates negatively with Abasement only in girls. There also is a significant difference between boys and girls in "irritability," the difference being almost .6, with the girls showing the negative relationship of —.35. Furthermore, girls tending toward Abasement do not show inclination to be dissatisfied, whereas boys have it to an extent almost significantly higher, namely, .46.

This brings us to a point where sex differences may be discussed in a more general way. Let us compare the two drives, Abasement and Aggression. The considerations of the preceding paragraph show that masochistic girls in our society tend to be better adapted than masochistic boys: they tend to be unaffected, non-resistant to authority, unselfish, not irritable and not too dissatisfied, whereas masochistic boys tend to be dissatisfied, irritable, and anxious. On the other hand, there is a tendency for Aggression to correlate with undesirable features in girls more than in boys, as mentioned above. While aggressive boys are markedly active, aggressive girls tend more often to be irritable. A reverse picture to Abasement is also shown in the case of Recognition. In contrast to boys seeking recognition, girls who strive for recognition tend to resist authority, to be comparatively indifferent to the group, and to be dissatisfied, irritable, selfish, and irresponsible, quite aside from those desirable and undesirable features which they share with the boys who strive for recognition.

On the basis of our findings as well as from general assumptions we may consider the striving for aggression and recognition more an aspect of adjustment to our culture when found in boys than when found in girls, and abasement a feature of adjustment to our culture when found in girls, but less specifically so when found in boys. The findings discussed above could thus be summarized and tentatively generalized in the following way: undesirable forms of behavior in social situations are especially displayed by boys rating high on feminine drives and by girls rating high on masculine drives.

The remaining two variables in our list of drives are Succorance and Achievement. They have, in common with Abasement, a general lack of relationship with most of the social situation items.

In the case of Succorance, only a few relationships are significant, and most of these are to be found in girls. Girls rating high in Succorance tend to be "attention-seeking" (.45) and "affected" (.41), "self-assertive" and "dependent on approval" (.37 and .38), and "talkative" (.40), "dissatisfied" (.43), "irritable" (.43), "impulsive" (.42), and "selfish," "irresponsible" and "exploitive" (.42, .39, .49). The highest though not quite significant relationship of Succorance for boys is with "tenseness" (.35).

In contrast to Succorance, Achievement shows almost all of its significant relationships to situational behavior in boys and not in girls. Boys rated high on the drive for Achievement tend to seek adult company (.51), not to resist authority, (—.40), to be socially self-confident (.37), not to be irritable (—.36), not to be selfish and irresponsible (—.44 and —.48), to be socially adjusted (.37) and to show smooth social functioning. As will be seen even more clearly in Chapter VIII, the drive for Achievement is associated with real integration of personality and internalization of tasks and social responsibilities. The highest figure for girls is —.39 indicating independence of approval in girls rated high on Achievement. The emotional independence of girls rated high on Achievement has already been emphasized in Chapter V where it was pointed out that the drive for Achievement shows some correlation with the drive for Autonomy and other more active drives, which was not found in boys.

D. RELATIONSHIPS OF SINGLE BEHAVIOR ITEMS TO THE RATED DRIVES

Instead of proceeding by rows in Table 12, one may directly compare values in a given column. In this way a single behavior item can be analyzed with respect to its relationships to the various drives. Such an analysis will be attempted now for some of the

33 situation items. This analysis will cut across previous discussion, but with emphasis on differentiation in the vertical direction.

Let us consider first the item "selfishness" (sixth from the end) which is interesting because of the rather marked sex differences. Its correlation with Social Ties is negligible for both sexes. There is a correlation of between .5 and .6 for both sexes with the fourth and fifth variables, Aggression and Escape. With Recognition, Control, and Succorance, however, the girls show correlations of around .45, whereas there is practically no correlation with these items in boys. There is a negative correlation of —.44 with Achievement in boys, whereas girls show no relationship, and of —.43 in girls with Abasement whereas the boys show no relationship. As we have mentioned above, the undesirable feature of "selfishness" is overcome by self-sacrifice (or masochism) in girls, but not in boys. On the other hand, selfishness in boys seems to be incompatible with work, whereas there is no relationship between attitude toward motivation to work (Achievement) and "selfishness" in girls.

Among the items of overt social activity, the following are most clearly differentiated in their relationships to our list of drives: "grooming activity," which drops from around .4 in its relationship to Recognition to about —.45 in its relationship to Abasement; "interest in the opposite sex" and "reference to the opposite sex" and "orientation toward the opposite sex" which drop from around .5 in the case of Social Ties and Recognition to around —.2 or —.3 in the case of Abasement. It is interesting that in the in-between variable of Aggression there still is relationship with "reference to the opposite sex" (when none of the opposite sex is present) yet the initiating of contact with the opposite sex ("interest in the opposite sex") has almost vanished (for boys). This latter item shows even a slightly negative coefficient, in boys, with Escape, a fact which makes boys rated high on Escape more similar to those rated high on Abasement than to those rated high on the first four drives. A difference between boys high on Escape and boys high on Abasement in their relation to the opposite sex is that the former still do show reference to the opposite sex whereas the latter do not even show this. Boys rated high on Social Ties show the greatest "interest in the opposite sex" and "reference to the opposite sex." For Recognition, Control, Aggression, and especially Escape, relationships with "reference to" are higher than with "interest in" the opposite sex. Girls however, show greatest "interest in opposite sex" when rated high on Aggression, Recognition, and Escape. This holds also, but to a lesser degree, for Control and Social Ties. Like the boys, girls rated high on Abasement are likely to be low on the two items.

The figures for "social self-confidence" drop steadily except for Achievement, from around .5, in the case of Social Ties, Recognition, and Control, to —.3 for Abasement.

For "attention-seeking" the pattern is similar. The highest single coefficient is .83 characterizing the relationship between Control and "attention-seeking" in boys. For Aggression the value is almost as high for both boys and girls. Social Ties, Recognition, and Escape show coefficients of about .6, whereas they are around zero for boys in Succorance and Achievement, and become slightly negative in Abasement.

A considerable drop is also found for "exploitiveness," which reaches about .8 in the case of Aggression and drops down to —.13 for boys and —.46 for girls in the case of Abasement.

E. SYNONYMS IN COLLOQUIAL REFERENCE TO DRIVES AND MANIFESTATIONS

A question of special interest arises in connection with the fact mentioned in the introduction, that in common language, similar or identical terms are often employed to characterize both motivational tendencies and forms of behavior. This may be one of the reasons for the attempt to eliminate reference to motivation altogether in an objective psychology. The relationships seem, however, to be more tangled than a simple terminological identification would permit us to expect, as became apparent in our discussion of Table 12. To be sure there are no identical terms if we compare the list of drives with the list of behavior items. But for nearly every drive we find one or a few manifestations which strike us as particularly appropriate or congenial, e.g., "self-assertion" for Control, "social participation" for Social Ties, "dependence on approval" for Recognition, and lack of "social self-confidence" for Abasement.

The closest correspondence is found in the case of self-assertion (bossiness) and Control (.7). The relationships between synonymous drives and manifestations drop from there to .3 for lack of "self-confidence" and Abasement; to .5 for "social participation" and Social Ties, and to .66 in boys and only .35 in girls for "dependence on approval" and Recognition. The lower the correlation the greater is the indication that the corresponding or "natural" manifestation of the drive in question is inhibited, as is, for instance, the case with Recognition in girls, or Abasement in both sexes.

A problem to be distinguished from the one concerning relationships between drives and corresponding manifestations, is that of the relationship between drives and the chief, synonymous goals toward which they are directed. In fact, "drives" seem to be more often named after their goals than after their immediate behavioral manifestations. One of the main goals of the drive for Control is leadership. The relation between Control and "leadership" is .60 for boys and .29 for girls. This suggests that girls either do not reach their goal of controlling as well as boys or that there are other main types of goals, e.g., more subtle forms of Control, which are important for the girls rated high on that variable. In any case, the importance of a goal for an individual as indicated in his drive ratings does not automatically imply its attainment. The drive for Social Ties refers to a striving for general social acceptance (see the definitions in Chapter II). Its relation to the most closely corresponding overt observational item, "popularity," is however, only around .2 for "popularity with the same sex," and not much higher for "popularity with the opposite sex." It thus seems to be easier to become a leader with a strong drive for Control than to become popular with a strong striving for Social Ties. Or else leadership is often taken as a cue to infer a striving for Control, at least in the case of the boys, whereas presence or absence of popularity is not so much used as a cue for the significance of popularity for the individual (drive for Social Ties). Thus not only the relationship between drive and manifestation (technique) but also that between drive and achieved goal is ambiguous.

VII. DRIVE PATTERNS AND BEHAVIOR PATTERNS

A. ALTERNATIVE BEHAVIOR MANIFESTATIONS OF DRIVES AS REPRESENTED BY MULTIPLE CORRELATIONS

In this chapter the complex relationships between rated drives and behavior in social situations will be elaborated with respect to certain aspects which have not yet been dealt with due to limitations of technique.

The first of these questions is the following: Is it true that for each drive there is a standard set of manifestations exhibited more or less consistently by all persons possessing the drive? If so, drives are nothing but names for clusters of manifestations. Or do we find that individuals possessing a certain drive will exhibit either one or another set of manifestations? In such a case there are two or more sets of behavioral patterns functioning in an "alternative" fashion in the expression of the drive.

To answer these questions one has to correlate rated drives with complex features such as "the presence of either this manifestation or that manifestation." There are several possibilities to be considered here. One may interpret the concept of alternative manifestation in the sense of mutual exclusiveness, in which case a person should get a high score on one manifestation but not on the other. Or one could define "either-or" in the sense of "and/or"; in this case a person scoring high on one manifestation may score high, low, or medium on the second, although both manifestations may be closely related to the drive.

A simple and direct statistical technique available for the study of joint contributions of two or more unrelated variables to a third is the multiple correlation. We have used the multiple correlation coefficient to obtain the correlation between the drive and best-weighted sum of the ratings on the two (or more) manifestations. The latter represent the alternative expressions of the drive in question.[35]

By means of the multiple correlation coefficient one can study the relationship of a single drive to two manifestations, or the relationship of one manifestation to two different drives. We will consider first the former of these two cases.

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[35] It is to be noted that multiple correlation provides an adequate index of the relationships involved only if the alternative manifestation is of an additive sort and relationships linear. In a case other than the additive possibility of alternative expression, multiple correlation will underestimate the true relationship.

One of the major findings in the preceding chapter was that five of our drive variables showed differential relationships with the two distinct classes of behavioral manifestations represented in our list. One class of behavioral manifestations was labelled "overt social activity," the other "emotionally maladjusted behavior." The fact that there was a differential relationship suggests, as would be expected, a certain degree of independent variability between these two classes. If such independent variability exists, multiple correlations between drives and the two classes of manifestations should be considerably higher than the single correlations of the drives with the items in the two classes, provided that the latter correlations are significantly different from zero.

In order to investigate this question, intercorrelations between behavior items were computed. Since it was not possible at the time to do this for all the 528 possible combinations among the 33 behavior items used, the 25 more important items were selected and correlations computed for boys and girls separately, yielding a total of 600 coefficients. An inspection of the table of intercorrelations[30] showed that the cross-correlations between items of one and the other class were, on the whole, unreliably different from zero, with small negative as well as with small positive values (see Tables 13 and 14). The behavior manifestations in the two classes are thus seen to be mutually independent. Since items in each class, however, have shown positive relationships to some of the drive variables, the hypothesis of alternative manifestations is partially confirmed.

To investigate this hypothesis further, it was planned to make a detailed analysis of alternative manifestations, for the drives for Recognition and Aggression. These drives were selected on account of their general psychological interest and the fact that they showed high average correlation with the behavior items (cf. Table 11). A systematic use of the multiple correlation technique was made

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[30] The intercorrelations between the behavior items used in our multiple correlation study may be found in Tables 13 and 14. Due to lack of space the complete table has not been presented here in full but is on file at the Institute of Child Welfare.

TABLE 13

ALTERNATIVE MANIFESTATIONS FOR DRIVE FOR RECOGNITION

S	M	Sex	r_{CS}	r_{CM}	r_{SM}	$R_{C\cdot SM}$
	Irritability					
Energy Output		B			—.27	
		G			—.14	
Social Participation		B			—.30	
		G	.45	.52	—.05	.71
Social Self-Confidence		B			—.50	
		G	.56	.52	.00	.76
Leadership		B			—.38	
		G	.38	.52	—.06	.66
Exuberance		B			—.52	
		G			—.53	
Heterosexual Interest		B			—.19	
		G	.46	.52	.05	.68
Grooming Activity		B			—.16	
		G	.42	.52	.10	.64
	Tenseness					
Energy Output		B	.50	.46	.25	.61
		G			.10	
Social Participation		B	.45	.46	.02	.64
		G	.45	.30	.17	.50
Social Self-Confidence		B	.53	.46	—.08	.73
		G	.56	.30	—.11	.67
Leadership		B	.46	.46	—.13	.70
		G	.38	.30	—.13	.59
Exuberance		B	.49	.46	—.03	.68
		G			—.18	
Heterosexual Interest		B	.50	.46	.22	.62
		G	.46	.30	—.24	.63
Grooming Activity		B	.38	.46	.00	.60
		G	.42	.30	—.19	.57
	Frequent Mood Swings					
Energy Output		B	.50	.35	.16	.57
		G			.12	
Social Participation		B	.45	.35	.16	.53
		G	.45	.55	.31	.62
Social Self-Confidence		B	.53	.35	—.12	.60
		G	.56	.55	.15	.73

TABLE 13 (*continued*)

S	M	Sex	r_{CS}	r_{CM}	r_{SM}	$R_{C \cdot SM}$
Leadership		B	.46	.35	—.07	.60
		G	.38	.55	.04	.66
Exuberance		B	.49	.35	—.12	.64
		G			—.27	
Heterosexual Interest		B	.50	.35	.16	.66
		G	.46	.55	.15	.67
Grooming Activity		B	.38	.35	—.15	.56
		G	.42	.55	.12	.66
	Selfishness					
Energy Output		B			—.15	
		G			—.11	
Social Participation		B			—.18	
		G	.45	.45	.07	.62
Social Self-Confidence		B			—.29	
		G	.56	.45	—.02	.73
Leadership		B			—.26	
		G	.38	.45	—.10	.62
Exuberance		B			—.29	
		G				
Heterosexual Interest		B			—.04	
		G	.46	.45	.14	.60
Grooming Activity		B			—.14	
		G	.42	.45	.21	.56
	Irresponsibility					
Energy Output		B			.15	
		G			.00	
Social Participation		B			.22	
		G	.45	.45	.33	.55
Social Self-Confidence		B			—.11	
		G	.56	.45	—.05	.74
Leadership		B			—.06	
		G	.38	.45	—.04	.60
Exuberance		B			—.03	
		G			—.16	
Heterosexual Interest		B			—.01	
		G	.46	.45	.23	.58
Grooming Activity		B			—.22	
		G	.42	.45	.26	.55

with each of these drives in relation to two or more manifestations. From the list of 25 behavior items for which intercorrelations were available, those items were selected which fitted into the above classes. This selection was based on purely psychological grounds, with the following notions explicitly in mind. One group was to comprise behavior items representative of "overt social activity or free expression of the drives in question" and the other, those items representative of "emotional maladjustment or of inhibition of Aggression and Recognition."[37] Of the items selected, only those are considered which showed a correlation of at least .30, either for boys or for girls, with Recognition or Aggression. The two classes were eventually constituted by the following items: in Group *"S"* (overt social activity) the items "grooming activity," "energy output," "social participation," "social self-confidence," "leadership," "exuberance," "orientation toward the opposite sex," and in Group *"M"* (emotionally maladjusted behavior) the items: "irritability," "tenseness," "frequent mood swings," "selfishness," "irresponsibility."

The results for the drive for Recognition are shown in Table 13 and for Aggression in Table 14. In Columns *S* and *M* are presented the behavior items to be considered. The next two columns show the correlation coefficients of the drive variable in question (*"C"* or *"A"* respectively) with the two behavior items for boys and girls separately). All the figures are thus taken from Table 12. Whenever one or both of the corresponding correlations in one of the two columns is below .30, the space for the entire pair of coefficients is left blank. In the next column are shown the intercorrelations between the various behavior items in Groups *S* and *M*. Since this is material not presented in any of the other tables, the figures are shown in full whether or not they are used for the computation of multiple correlations. Tables 13 and 14 are, however, identical with regard to this column. The last column presents the multiple correlation coefficients between the drive variable and the combination of manifestations in question. These coefficients are computed only where both zero order coefficients in the first two columns of results

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[37] Mr. Donald T. Campbell and Mr. Frederic M. Geier, two independent workers unfamiliar at that time with the details of our results, selected the behavior items on the basis of this instruction.

TABLE 14

ALTERNATIVE MANIFESTATIONS FOR DRIVE FOR AGGRESSION

S	M	Sex	r_{AS}	r_{AM}	r_{SM}	$R_{A \cdot SM}$
	Irritability					
Energy Output		B	.42	.41	—.27	.69
		G			—.14	
Social Participation		B	.48	.41	—.30	.75
		G	.39	.74	—.05	.85
Social Self-Confidence		B			—.50	
		G	.45	.74	.00	.87
Leadership		B	.32	.41	—.38	.66
		G	.36	.74	—.06	.84
Exuberance		B	.30	.41	—.52	.73
		G			—.53	
Heterosexual Interest		B			—.19	
		G	.44	.74	.05	.84
Grooming Activity		B			—.16	
		G	.36	.74	.10	.79
	Tenseness					
Energy Output		B	.42	.48	.25	.57
		G			.10	
Social Participation		B	.48	.48	.02	.67
		G	.39	.35	.17	.48
Social Self-Confidence		B			—.08	
		G	.45	.35	—.11	.60
Leadership		B	.32	.48	—.13	.62
		G	.36	.35	—.13	.54
Exuberance		B	.30	.48	—.03	.57
		G			—.18	
Heterosexual Interest		B			.22	
		G	.44	.35	—.24	.64
Grooming Activity		B			.00	
		G	.36	.35	—.19	.56
	Frequent Mood Swings					
Energy Output		B	.42	.61	.16	.69
		G			.12	
Social Participation		B	.48	.61	.16	.72
		G	.39	.71	.31	.73
Social Self-Confidence		B			—.12	
		G	.45	.71	.15	.79

TABLE 14 (*continued*)

S	M	Sex	r_{AS}	r_{AM}	r_{SM}	$R_{A\cdot SM}$
Leadership		B	.32	.61	—.07	.71
		G	.36	.71	.04	.78
Exuberance		B	.30	.61	—.12	.72
		G			—.27	
Heterosexual Interest		B			.16	
		G	.44	.71	.15	.79
Grooming Activity		B			—.15	
		G	.36	.71	.12	.76
Energy Output	*Selfishness*	B	.42	.51	—.15	.72
		G			—.11	
Social Participation		B	.48	.51	—.18	.77
		G	.39	.66	.07	.75
Social Self-Confidence		B			—.29	
		G	.45	.66	—.02	.81
Leadership		B	.32	.51	—.26	.69
		G	.36	.66	—.10	.79
Exuberance		B	.30	.51	—.29	.69
		G				
Heterosexual Interest		B			—.04	
		G	.44	.66	.14	.75
Grooming Activity		B			—.14	
		G	.36	.66	.21	.70
Energy Output	*Irresponsibility*	B	.42	.65	.15	.73
		G			.00	
Social Participation		B	.48	.65	.22	.74
		G	.39	.62	.33	.65
Social Self-Confidence		B			—.11	
		G	.45	.62	—.05	.79
Leadership		B	.32	.65	—.06	74
		G	.36	.62	—.04	.73
Exuberance		B	.30	.65	—.03	.73
		G			—.16	
Heterosexual Interest		B			—.01	
		G	.44	.62	.23	.69
Grooming Activity		B			—.22	
		G	.36	.62	.26	.66

are at least .30 and thus can be found only in those rows for which figures are presented throughout.

For the majority of rows both zero order coefficients with the drive variable in question are .3 or more and thus presented in the table along with the multiple correlations based upon them. In all the rows fulfilling this criterion the intercorrelations between the S-item and the M-item are mostly close to zero and quite often slightly negative. Thus we find that the multiple correlation often represents a considerable gain when compared with the two coefficients in the first pair of columns. For example, as shown in the third row of Table 13, *"social self-confidence" and "irritability"* correlate with Recognition in girls .56 and .52 respectively, and their intercorrelation is zero. The multiple correlation of Recognition with "social self-confidence" and/or "irritability" is .76. The rise of a correlation coefficient from the fifties to the seventies means a great deal for purposes of prediction. Whereas not too much can be predicted about "social self-confidence" as such, or "irritability" as such, of a girl known to rate high on Recognition, it can be said with a very high degree of certainty that she will be found to be socially self-confident if not irritable, or irritable if not socially self-confident, or both socially self-confident and irritable.[38]

In glancing over the column of multiple coefficients, the highest values are found in the upper portion of Table 14, representing alternative relationships of manifestations with ratings on Aggression. The highest value, .87, is obtained with the same combination of manifestations which has just been discussed, "social self-confidence" and "irritability" in girls. To be sure, the two contributors to this multiple coefficient are not of equal strength as was true in the case discussed above. In fact the group of coefficients in this part of the table which are around .8 or more are based in part on the zero order coefficient of .74 between "irritability" and aggression.

The rise in correlation by applying the multiple correlation technique is slightly more marked in boys when the combination of the S-items with "tenseness" is under consideration.

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[38] The gain in efficiency of prediction over a zero correlation is about 16 per cent in the case of our zero order correlations, and about 45 per cent for the multiple correlation.

For example the multiple correlations for boys, of Recognition with "social self-confidence and/or tenseness" and with "leadership and/or tenseness" are .73 and .70 respectively, though the zero order coefficients on which they are based are .53 and .46 and .46 and .46, respectively. The reason for the comparatively large increase from the raw to the multiple correlations lies in the fact that in each case the intercorrelation between the two behavioral items is slightly negative.

The highest increase due to a negative intercorrelation between behavior items is found in the upper part of Table 14 for the combination of "exuberance" and "irritability." These two behavior items are incompatible to a certain extent as indicated by a correlation of —.52, yet they both correlate positively (though in one case not quite significantly) with Aggression. The multiple correlation between Aggression and the two manifestations is .73 as contrasted with .41 which is the higher of the two correlations upon which the multiple coefficient is based. Less drastically, the following patterns point in the same direction. For boys, the intercorrelations of "energy output," "social participation," and "leadership," on the one hand, with "irritability," on the other, are —.27, —.30, and —.38 respectively. The corresponding correlations of these items with Aggression range from .32 to .46. Multiple correlations, however, are between .66 and .75. As in the above mentioned case, the relationships described tend, to a certain extent, toward an exclusive "either-or" rather than toward an "and/or" type. In other words, taking the example of the relationships between "leadership," "irritability," and Aggression, it might be said that aggressive boys either succeed in becoming leaders (in which case they probably will not be irritable) or they are irritable (in which case they probably have not succeeded in becoming leaders). What prevents this case from being an ideal example is the fact that all three coefficients involved are rather low or even barely significant (.32, .41, —.38). Thus the statement made above is, as it stands, a gross exaggeration with respect to the degree to which this and other similar complexes of relationship actually hold.

In partial support of the above interpretation, however, we may point to the fact that multiple correlations for boys of Aggression with "leadership," on the one hand, and the remaining behavior items of emotionally maladjusted behavior, i.e., "tenseness," "frequent mood swings," "selfishness," and "irresponsibility" are likewise satisfactory (from .62 to .74) and that in all of those cases the interrelationship of "leadership" with the *M*-items is negative, ranging from —.06 to —.26.

Furthermore, in some cases the girls show a similar trend, such as in the case of "leadership" and "selfishness." Between these two items there is a correlation of —.10, and a multiple correlation of .79 (based on zero order coefficients of .36 and .66) with Aggression.

A graphic description of the numerical results presented in Tables 13 and 14 is given in Figures 3 and 4. There are four rows in each

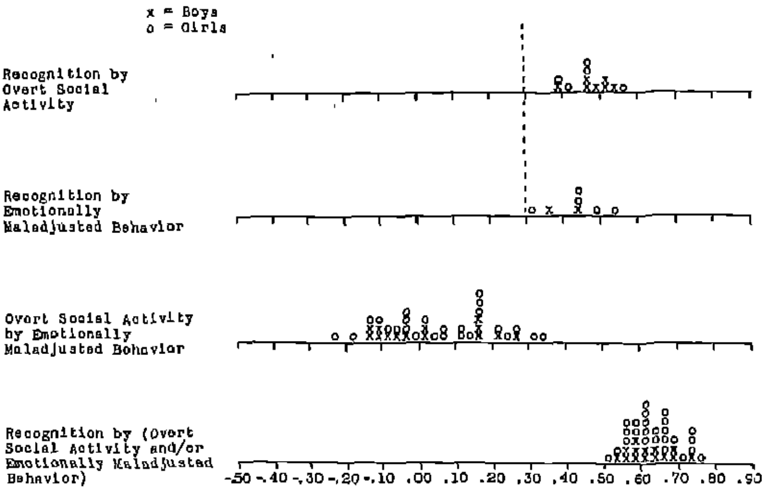


FIGURE 3
ZERO-ORDER AND MULTIPLE CORRELATIONS, DRIVE FOR RECOGNITION, AND BEHAVIORAL MANIFESTATIONS

figure, each of them representing the frequency distribution of a particular type of correlation coefficient. Only those coefficients are plotted which enter the computation of a multiple correlation according to our criterion. Thus all figures which appear in completed rows in Tables 13 and 14 are represented in the figure, some of these coefficients being, however, repetitions and thus appearing only once in Figures 3 and 4. Coefficients for boys are represented by the symbol *x* and for the girls by the symbol *o*. For Recognition

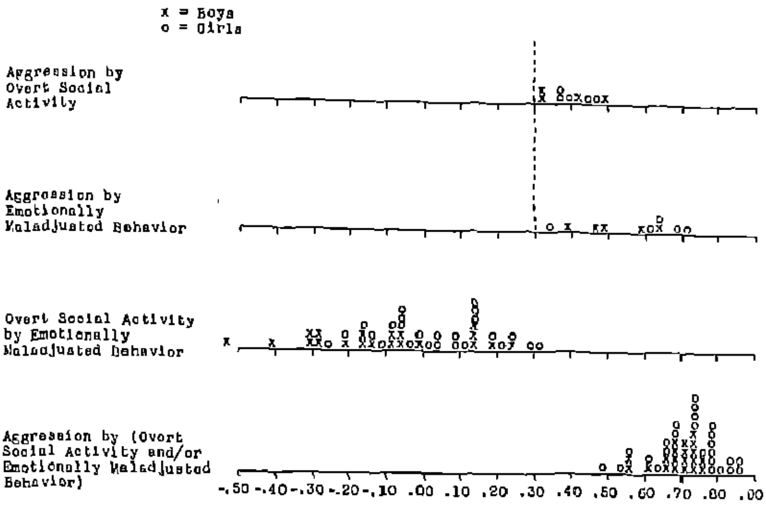


FIGURE 4

ZERO-ORDER AND MULTIPLE CORRELATIONS, DRIVE FOR AGGRESSION, AND BEHAVIORAL MANIFESTATIONS

the number of *CS* and *CM* coefficients entering the computation of multiple correlations in accordance with our criterion is, as can be read from the first two rows of Figures 3, 7 and 5, and 2 and 5, respectively, for boys and girls. The number of intercorrelations used, and at the same time the number of multiple correlations computed, for boys and for girls, is equal to the products of the corresponding figures presented above, 14 and 25, for boys and girls, respectively. They are shown in the third row of Figure 3.

The correlations of Recognition with the *S* and the *M* items range from .38 to .56, with means and medians between .4 and .5. An important fact is that relationships are about equally strong with the overt social activity group and the emotional maladjustment group of items. This is particularly true for the girls with the means being .45 for both groups of five coefficients. For boys the number of emotional maladjustment items yielding sufficiently large correlations is smaller than the corresponding number of overt social activity items and the mean is likewise somewhat higher for the latter (.47) than for the former (.41). It has already been noted that boys may frequently have a readier opportunity than girls to manifest a striving for Recognition, and may therefore less often show symptoms of emotional maladjustment.

Correlations (r_{SM}) between items of pairs selected because of their sufficiently high correlations with Recognition, and used in the computation of multiple correlations, range from —.24 to .33, with a mean of .02 for boys and of .05 for girls.

The multiple coefficients for Recognition are shown in the last row of Figure 3. They range from .50 to .76 with a mean of .62 for boys and .64 for girls. This represents an average gain of almost .2 over the coefficients in the first two rows.

The chief difference between the complex relationships of Recognition and those of Aggression (the latter being shown in Figure 4) can be summarized as follows: for the items selected as *S* and *M* representatives and used to compare Recognition and Aggression, we find that in the case of Aggression there are considerably higher correlations with *M* (emotionally maladjusted behavior) than with *S* (overt social activity). The former range from .41 to .74 and average .53 for boys and .62 for girls (second row of Figure 4), whereas the latter range from .30 to .48 and average .38 for boys and .40 for girls (first row). The cross-item correlations entering the computation of multiple correlation for Aggression are more often and more distinctly negative, ranging from —.52 to .33 and averaging —.09 for boys, and .05 for girls.

Furthermore, multiple correlations are higher for Aggression than for Recognition. As shown in the last row of Figure 4, they range from .48 to .87 and average .70 for boys and .73 for girls and thus are on the average almost .1 higher than those for Recognition.

The analysis was carried further to multiple correlations of the second order, involving one drive and three manifestations. In part, those items were utilized which stood relatively isolated from both the *S* and *M* categories. But even within the material selected for multiple correlations of the first order, noticeable increases can be found by proceeding to higher levels of complexity. Instead of giving the material extensively we refer to one representative example only. The first order multiple correlation of the drive for Aggression with either "leadership" and/or "irresponsibility" is raised from .74 to a second order multiple coefficient of .8 by adding "tenseness" as a further alternative manifestation.

Summing up, the material in Tables 13 and 14 and Figures 3 and 4 shows that the drives for Recognition and Aggression are tied up with alternative manifestations, one in the field of overt social activity (*S*) and the other in the field of emotional maladjustment (*M*). One of the two manifestations, or both at the same time, may be present. Some aggressive or ambitious subjects are found to be socially active and free in expression: this is the positive adjustment side of these drives. Others are inhibited, showing an anxious, irritable pattern: this is the maladaptive aspect of Aggression and Recognition. It may be regarded as a result of frustration in direct expression.

Recognition and Aggression show fairly marked relationships to overt social activity (*S*) and emotionally maladjusted behavior (*M*), whereas *S* and *M* are for the most part uncorrelated with each other. This fact supports the interpretation of drives as dynamic factors rather than as summative labels for behavior clusters.

In many studies of personality the concept of "adjustment" furnishes a primary basis for behavior classification. Socially reactive behavior and emotionally maladjusted behavior seem to fall readily into distinct classifications. Yet in this chapter we have seen that in terms of underlying dynamics they may be intimately associated.

B. Behavior Profiles and Regression Profiles of Individuals Rated Extreme on Drives

The problem of alternative relationships can be discussed in a more concrete way by examining behavior profiles of single cases. Figure 5 shows the profiles of boys representing the upper and lower extremes with respect to ratings on the drive for Recognition.

On the right side of Figure 5 are shown the profiles of each of the four cases having a sigma score of 1.4 on Recognition which is the highest sigma score obtained on this drive. The profiles cover all of the 33 manifest behavior items in terms of sigma scores. The dotted line does not represent an individual, but is what might be called a "regression profile." The regression profile is based on estimated "most probable scores" for each behavior item. These scores are obtained by making use of the regression equation for "*y* on *x*," where *y* is the behavior items and *x* the drive ratings. Thus, the obtained Recognition score for these four cases (1.4) is multiplied

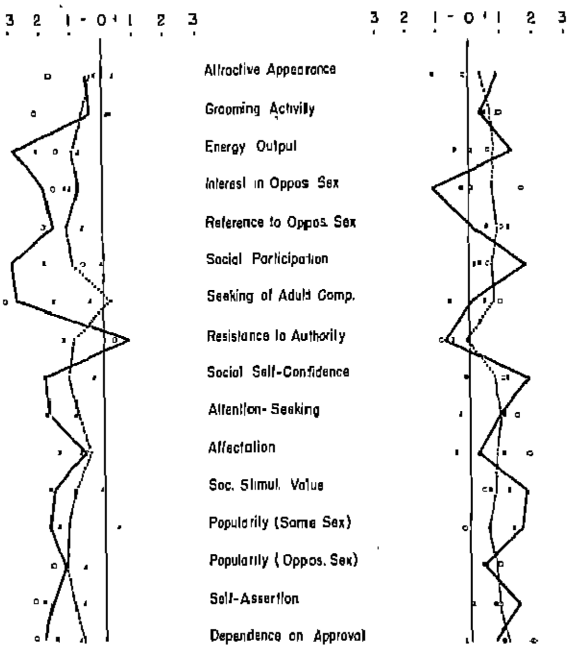


FIGURE 5

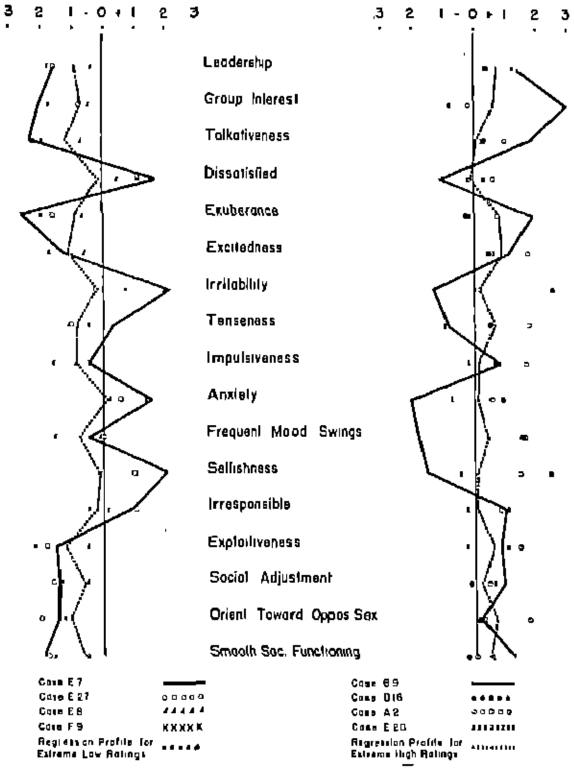
BEHAVIOR PROFILES OF BOYS RATING EXTREME ON DRIVE FOR RECOGNITION

by the correlation coefficient between Recognition and each behavior item. This estimated profile thus represents what we should expect if the correlation coefficient is taken as a basis for prediction. In its general shape it is similar to the corresponding profile of correlation coefficients shown in Table 12.

As a group the four subjects correspond fairly well (in their obtained scores on behavior items) with the general trend represented by the regression profile. For most items characterized by a high point of the regression profile, all four or at least three of the individual sigma scores are above the zero line, which means that the respective ratings are above the average.

An analysis of individual profiles reveals, however, that in some cases one set of manifestations stands out at the expense of another. Thus Case *B*-9 (heavy black line on the right side) is found to have been rated higher than expected on the following items: "energy

Figure 5 (continued)



output," "social participation," "social self-confidence," "social stimulus value," "popularity with the same sex," "bossiness," "leadership," "talkativeness," "exuberance," and above all on "group interest." He therefore can be characterized as well adjusted with respect to the category "overt social activity." On the other hand, this boy is rated as comparatively little "dissatisfied," "irritable," and "tense," as not having "frequent mood swings," and as very "unselfish" and lacking in "anxiety." Therefore he has to be characterized as consistently low on items of emotional maladjustment. Minor inconsistencies in this generally favorable pattern are given by the fact that relationship to the opposite sex seems not to be developed as well as should be expected and that ratings are comparatively high on the item "irresponsibility."

Case *E*-28 (indicated by *z* symbols) also illustrates rather clearly the pattern of highly adjusted "overt social activity" and low "emotionally maladjusted behavior."

The opposite alternative in the pattern of manifestations is represented by Case *B*-18 (indicated by · symbols), who is rated as very irritable and selfish as well as rather "anxious," "irresponsible" and given to "frequent mood swings"; whereas on the other hand he shows little "energy output," "interest in the opposite sex," "social self-confidence," and "exuberance," does not "seek adults" as should be expected, and is quite low on "attractive appearance" and "interest in the group."

The fourth boy in our group, Case *A*-2 (indicated by *θ* symbols) is to some extent an illustration of the "and" in the phrase "and/or." This boy shows "interest in" and "orientation toward opposite sex," appears to be "socially self-confident," "showing off" and "affected" and "dependent on approval," but he is also "excited," "tense," "impulsive," "anxious," given to "mood swings," "selfish," "irresponsible," and "exploitive." Among the negative deviations from the expected scores according to his high rating on Recognition, we mention a "tendency to resist authority," to be not too "popular with the same sex" and to show little "group interest" and to be socially not too well adjusted. Thus it may be said that in this boy, overt social activity does not include some of the best items most indicative of good adjustment. This fact is characteristic of the degree of consistency regarding adjustment which probably holds for most of the "and" cases which may be found in our material.

The second row in Figure 5 represents individuals rated extremely low on the drive in question. In their general pattern the regression profiles are reversals of the regression profiles in the left half. The four cases do not have the same sigma score, two of them (*E*-7, black line on the left side and *E*-27, indicated by *o* symbols) being characterized by —2.2 and the other by —1.9. To simplify the picture, only one regression profile (dotted line on the left side of Figure 5) is shown, based on the assumption that all the four subjects have a sigma score of —2.0 on Recognition. Here again, various individual patterns can be distinguished. Case *E*-8 (indicated by Λ symbols) for example, is slightly but consistently above expectation in overt social activity; Case *E*-7 is low on this category but high on such items of emotional maladjustment as "dissatisfied," "irritable," "anxious," and "selfish," etc.

Cases extreme on the other drives have also been studied.' E.g., profiles of individuals extreme on the drive for Abasement tend to show very inconsistent patterns. This would follow from the flatness of the regression profiles—i.e., the low correlation coefficients of Abasement with behavior items (see Chapter VI). Among the cases extremely high on Abasement we find individuals with much and little social activity, emotionally adjusted as well as maladjusted cases. All the cases extremely low on Abasement, however, are above average in overt social activity. Freedom from Abasement seems to mean freedom from some kind of inhibitions which interfere with social activities.

C. ALTERNATIVE DYNAMICS BEHIND BEHAVIORAL MANIFESTATIONS AS INDICATED BY MULTIPLE AND PARTIAL CORRELATIONS

Thus far we have been dealing with the problem of ambiguity of manifestation of the drive variables. A complementary problem is the question as to whether and in what way a particular kind of manifestation may be caused by either this and/or that underlying dynamic factor. Obviously, relationships in this direction will not be unambiguous either.

A first approach to this problem is quite analogous to the one described in Section A of this chapter. It involves the multiple correlation of one manifestation with two drive variables. Multiple coefficients have, however, not been computed here as systematically as above. Altogether, 86 multiple correlations were computed for one manifestation with two drive variables. The selection was made on the grounds of general interest of the particular combination and probability of obtaining a sizeable increase in correlation. Thus, these coefficients are more arbitrarily selected than those reported in Tables 13 and 14.

The coefficients computed range up to .87. The latter correlation holds for girls, and is between "exploitiveness" on the one hand, and Succorance and/or Aggression on the other. The zero order coefficients are .49, .80 and .18. The rise is, however, not as large in this case as it is in several others. Among the other single multiple correlations we refer only to some of the more interesting, which are not necessarily the highest.

Many of the coefficients computed hold, as does the above example, only for girls, and for a combination of one of the manifestations in the category "emotionally maladjusted behavior" with Succorance, on the one hand and either Recognition, Control, or Aggression on the other. A reason for this is given by the fact that Succorance shows higher correlations with manifest behavior in girls than in boys and that at the same time its correlations with most of the other drive variables are rather low.

An example is the following: for girls, "exploitiveness" correlates .79 with Succorance and/or Recognition, the zero order coefficients being .48, .66, and .09. Succorance and/or Recognition furthermore correlate, in girls, with "irresponsibility," .57 (based on .39, .45, and .09); with mood swings, .62 (based on .33, .55, .09); with "irritability," .65 (based on .43, .52, .09); with "talkativeness," .58 (based on .40, .45, .09); with "dependence on approval," .50 (based on .38, .35, .09); and with "attention-seeking," .77 (based on .45, .66, .09).

Similar figures were obtained when Control or Aggression enters combinations of this kind instead of Recognition. The former is especially suitable since the correlation between Succorance and Control is only .06 in girls. In summing up it may be said that emotionally maladjusted and somewhat exhibitionistic girls are likely to be driven by ambitiousness (or dominance) and/or by a need for dependence (Succorance).

There are a number of cases in which one manifestation correlates positively with one drive and negatively with another in such a way that there is a large gain in the multiple coefficient. An example is the correlation in girls of "dependence on approval" with Achievement of —.39, and with Aggression of .39. The cross-correlation between Achievement and Aggression being .09, the resulting multiple coefficient is .58 suggesting that "dependence on approval" tends to occur in girls if there is little urge toward Achievement and/or if there is much tendency toward Aggression. Another example, again in girls, is the relationship of "selfishness" with Succorance and/or freedom from Abasement. The multiple correlation is .63, based on .42, —.43, .10. Similarly with "exploitiveness" the coefficient is .71. The rise in this case is particularly great, the basic coefficients being only .49, —.46, and .10. In boys "irresponsibility" is tied to a low rating on the drive for Achievement and/or a high rating on the drive for Aggression, the multiple coefficient being .78 (based on —.48, .65, —.08).

Another possible method of analyzing the relationships between a given manifestation and the underlying dynamics is through the use of partial instead of multiple correlations. This method yields the best results in cases where the cross correlation between the two drive variables is high, rather than low as was desirable for the application of the multiple correlation technique. In such cases it is then possible to say what the correlation between a given drive and a given manifestation would be if a certain other drive, correlating high with the first drive, were not permitted to vary and thus to influence the relationship in question. This procedure is an important help in isolating the effects of certain factors in determining certain manifestations.

Among the combinations of one manifestation and two drives for which partial correlations have been computed, we mention only some of the more interesting examples. The conceptual distinction between some of the drive variables was questioned above on account of the correlation between them. An outstanding case is Control versus Aggression. We limit our consideration to boys, for which the correlation between these two drive variables is .77. We noted in discussing the relationships of rated drives with manifestations, one of the chief differentiating features between these two drive variables was the fact that Aggression correlates .41 with "irritability," whereas Control shows a zero correlation. By means of partial correlation it is now possible to isolate the relationships of "irritability" with the drive for Aggression and for Control(Dominance) from another. The net correlation between Aggression and "irritability" is .63. The relationship between Aggression and "irritability" is thus considerably closer than was indicated by the coefficient of .41, which was based on a situation in which Control was permitted to influence the relationship. On the other hand, with Aggression partialled out, the relationship between Control and "irritability" becomes markedly negative, —.53, indicating that the drive for Control, when isolated, would show a decided tendency to lessen "irritability" whereas Aggression as such has the opposite effect. Quite similar in general pattern are the results when other behavior items in the "emotional maladjustment" group are substituted for "irritability," such as "selfishness," "irresponsibility," and "mood swings." In these cases, correlations with Control range up to .3 instead of being zero. On the other hand, correlations with Aggression are also higher, .51 to .65. As a result, partial correlations with Aggression range up to .72, whereas negative partial relationships with Control are somewhat less marked, from —.51 to —.35.

Quite the opposite picture appears when Aggression and Control are partialled out from their relationships with behavior items indicating good adjustment in terms of overt social activity, such as "social self-confidence," "popularity with the same sex," "leadership," and "group interest." To be sure, the relationships of these four behavior items with Control, ranging for boys for .42 to .60, show almost no further increase when Aggression is partialled out. But the slightly positive relationships with Aggression, ranging from .11 to .32 for the four behavior items, turn noticeably negative, about —.4 in three of the four cases, when Control is partialled out. In conclusion, partial correlation thus reveals, more clearly than raw correlations, the maladaptive emphasis of Aggression as contrasted with the adjustive character of the drive for Control. In view of this, the separation of the two categories, Aggression and Control, seems the more justified. In a similar fashion, partial correlation supports the distinction between Aggression and Escape. We refer only to one example in which Aggression is partialled out from the relationship between Escape and "self-assertion." In this case a significant raw correlation (of .42, in boys) disappears (or rather becomes slightly negative, —.15) when Aggression is taken out, quite in agreement with the general conception that Escape and "self-assertion" are not very congenial to one another unless we permit Aggression (which correlates .82 with Escape) to enter the picture.

D. PATTERNS OF SOCIAL BEHAVIOR AS RELATED TO PATTERNS OF DRIVES

In order to bring out more clearly some of our findings and to elaborate further upon the problem of total personality structure, a profile study was undertaken for groups of boys chosen as outstanding in either direction on a selection of items indicating "successful social activity" and *on the selection of items used above to represent* "emotionally maladjusted behavior." This resulted in the location of (*a*) 12 cases classified as "socially successful and emotionally well-adjusted"; (*b*) eight cases classified as "socially successful but emotionally maladjusted"; (*c*) eight socially unsuccessful and emotionally well-adjusted, and (*d*) seven socially unsuccessful and emotionally maladjusted boys, 35 subjects altogether. The average sigma score profiles, defining each of these groups in terms of six behavior items representative of social success and five behavior items representative of emotional maladjustment, are shown in Figure 6.

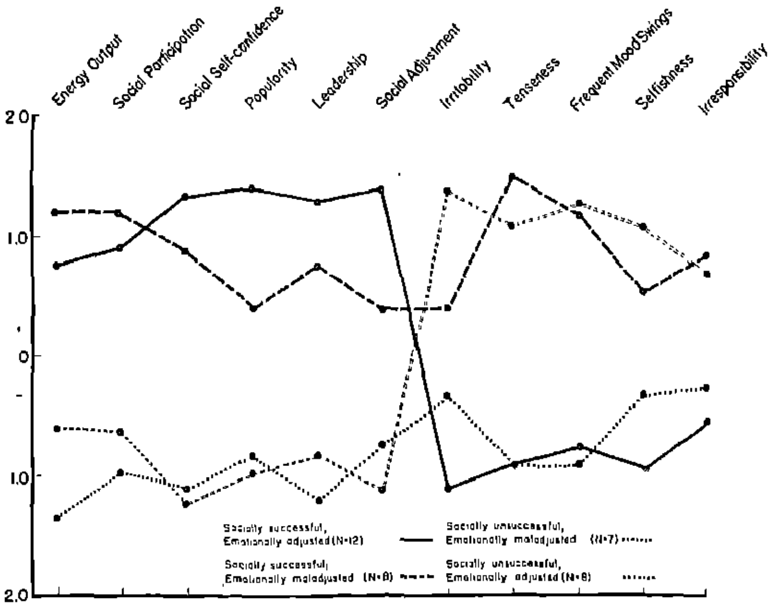


FIGURE 6

In Figure 7 the drive profiles of these four groups are shown, the sequence of drives being arranged according to closeness of their relationships to manifest behavior as was done for Table 3. The four behavior combinations show distinctly different patterns of rated

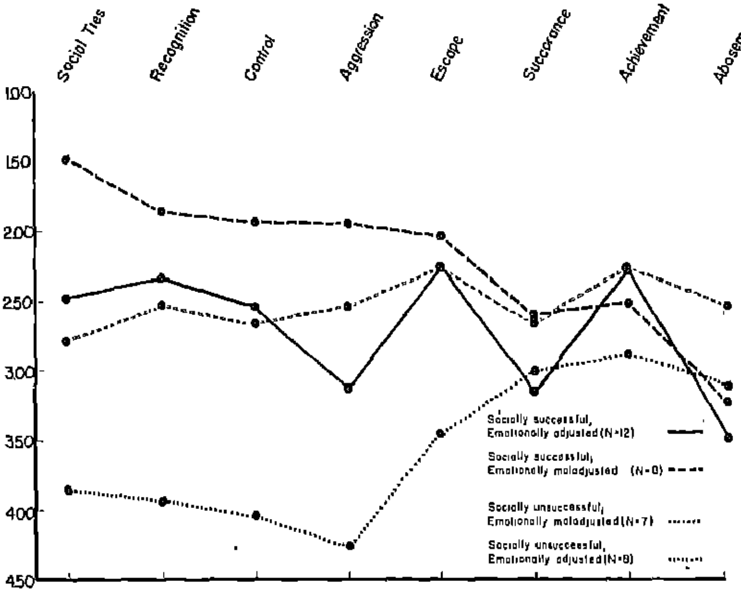


FIGURE 7

drives at least with respect to the first five drives which show closest relationships to behavior. The socially successful but emotionally maladjusted group is characterized as highly "driven": the group is above the rating average on all drives except Abasement, on which it is close to average. It is particularly high on the five dominance drives in the left half of the figure with the peak at the drive for Social Ties, followed by Recognition, Control, and Aggression. Next in the strength of drives appears to be the socially unsuccessful and emotionally maladjusted group. This expresses again the relationship to which we have repeatedly been able to refer, between "being driven" in a general way, and emotional maladjustment. The socially successful and emotionally well adjusted groups is characterized by being well above average in Social Ties, Recognition, Control, and Achievement, about average in Aggression, Escape, and Succorance and somewhat below average in Abasement. Most isolated from the rest is the drive profile for the socially unsuccessful but emotionally calm group, which is distinctly low on the five drives representing social dominance, and especially low on Aggression. Not being highly driven, this group seems not to be disturbed about its lack of social success.

The fact that distinct patterns of rated drives correspond to distinct patterns of manifest behavior seems to suggest that we may be able to predict, at least to some extent, general behavior patterns from knowledge of the general pattern of drives. This would offset the ambiguities found in the relationships of single drives and manifestations which are described in the concepts of alternative manifestations and alternative dynamics. It should be added that such a predictability would hold only for groups as a whole, since the variability from individual to individual was found to be relatively great within each of our groups. However, an analysis of the data would probably show that the differences between the profiles of the four groups are sufficiently marked to be called significant.

The behavior profiles (*T*-scores) of four small groups of boys (from four to seven in number) have also been analyzed (see Figure 8). In contrast to the previous example, the groups were selected on the basis of extreme ratings on the two drive variables,

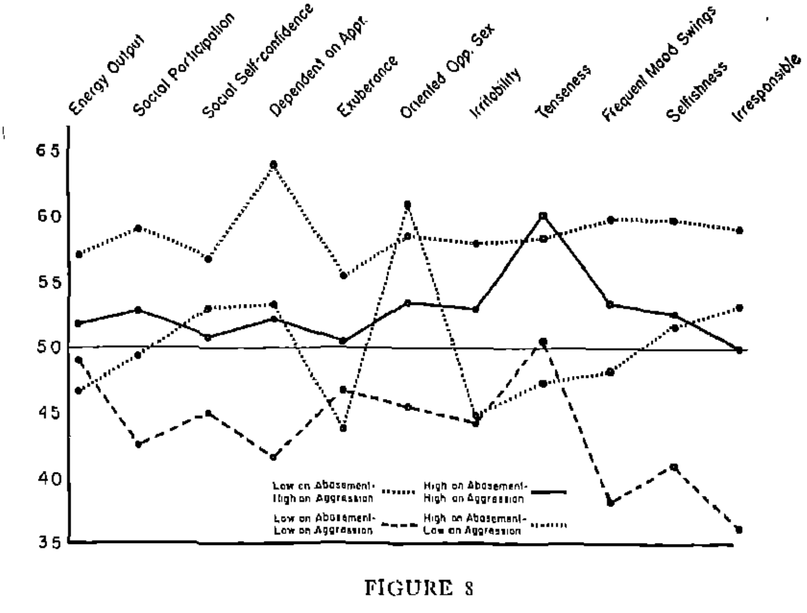


FIGURE 8

Abasement and Aggression. High Aggression with a low degree of Abasement was found to go with high ratings on both overt social activity and emotional maladjustment. High Aggression without the inhibiting influence of Abasement shows the greatest amount of expression. Where high Abasement accompanies Aggression, there is a definite lowering of overt social activity, and to some extent a lowering of expressed emotional maladjustment. Tenseness remains high since it is the most valid indicator of inner conflict among these items. A person high on Abasement may shrink from overt social activities, may even shrink from being irritable but will not be able to relax under the presence of opposing forces. Low Aggression with freedom from Abasement showed on the whole a low degree of overt social activity and also low ratings on the items of emotional maladjustment.

E. Similarity of Drive Pattern versus Similarity of Behavior as Represented by Correlations between Individuals

The inverted correlation technique, introduced by Stephenson (18) in which two individuals are correlated on an array of items, instead of two items on an array of individuals, has also applied to the problem of similarity in the total pattern of drive ratings. Thirty-six pairs of individuals were selected at random. The similarity of drive patterns was determined by computing rank-order coefficients between drive ratings received by two subjects. Similarity on behavior items was determined by computing Pearson coefficients for each pair. A somewhat surprising result is that, for the nine pairs most similar on drives (rank order coefficients ranging from .68 to .92), the correlations between their behavior patterns range from .73 to —.68. Thus some pairs of individuals very similar on drives are also very similar in their behavior patterns, but others are very dissimilar. A reason for this may lie in the fact that the drive pattern described by our ratings does not completely characterize the motivational pattern underlying behavior, and that some of the factors determining alternative manifestation have not been sufficiently represented. Another reason may be that environmental factors not entirely accounted for by drives determine the specific pattern of manifestation. An analysis of the behavior profiles of the two individuals with a drive correlation of +.84 and a behavior correlation of —.68 indeed reveals that one of them shows overt social activity, the other emotional maladjustment. This pair seems to be an extreme example of the wide variability of behavioral techniques as expressions of a certain set of motivational patterns.

Pairs of individuals with very dissimilar drive patterns also showed wide variability of behavior patterns.[38]

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[38] The apparent lack of relationships between drive patterns on one hand and behavior pattern on the other for pairs of individuals is expressed in a correlation coefficient of zero obtained between similarity of drives and similarity of social behavior. The correlation between similarity of drives and similarity of general traits (to be discussed in the next chapter) is .3.

VIII. DRIVES AND GENERAL TRAITS

A. RATINGS ON GENERAL TRAITS AND THEIR RELIABILITIES

In the two preceding chapters an analysis was made of the relationships between drive ratings and behavior observed in specific social situations. Interpretation was deliberately restricted as much as possible in the observations on behavior to secure a maximum of objectivity. Thus ratings on manifest behavior refer primarily to behavior as a technique. The terms used in characterizing the overt behavior items have to be understood in this particular sense. For example, a high rating on "social self-confidence" does not mean that the rater believed the subject to be fundamentally secure in his social contacts but rather that the subject manifested the gross symptoms of "inviting new situations requiring poise and confidence." Five of our nine drive variables, Social Ties, Recognition, Aggression, Control, and Escape, showed more or less clear-cut relationships with observation of this type which aided in clarifying the meanings of these drives. The three variables Succorance, Achievement, and Abasement, however, showed little relationship to the observed social techniques. General clinical knowledge as well as the close relationships of these drives to self-reports on the Adjustment inventory (see Chapter IX) suggest that these three variables represent important dynamic factors. This may be a further indication of the fact that social techniques do not reveal all motives. On general grounds three types of data should be distinguished, only two of which are thus far represented in this study. One of them involves specific behavior; another involves the dynamics behind behavior which our drive ratings attempt to approach. The third represents the more permanent adjustments and may include the abilities necessary to bring them about. In the present chapter an attempt is made to broaden the scope of our material so as to explicitly include this third type of data. The ratings introduced for this purpose we propose to call ratings of general traits. The term "general" refers to the summary character of these ratings as contrasted with the specificity of the behavior ratings. The term "traits" refers to the fact that an attempt is made to remain within the phenotype.[80] In this study however, the conceptual distinction between drives, specific behavior, and traits is not carried through as sharply as it might be. Our trait variables sometimes have motivational characteristics, e.g., the category "Strength of Superego"; and some of our behavior variables extend beyond the specific situation in the direction of more pervasive traits. However, the fact that certain terms such as adjustment, popularity, egotism (selfishness) appear in both rating lists does not imply that they refer to exactly the same thing, as pointed out above. In any case since this study is dealing with interrelationships within one level as well as with relationships between levels, not much harm is done if the boundaries between the various types of data are not always kept sharp.

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[80] The predominant use of the term "trait" for phenotypical as contrasted with genotypical classification was recently emphasized by Allport.

Being based on long range observations, the trait ratings were meant to summarize the impressions of the raters about status, abilities, and behavioral results, characteristic of the subjects. In explaining the rating program to the three judges it was emphasized that they should rate real adjustment, real security, etc., using their entire knowledge of the children's behavior and not merely the observation of behavior displayed in one particular situation.

The following rating list of traits[40] consists of 11 variables, the first of which is in five subdivisions, each rated separately (Table *A*). This list is largely compiled from Murray (15) and from Allport (1).

The trait ratings were made together with the drive ratings in the summer of 1940 and by the same three raters. The fact that they were made at approximately the same time and by the same individuals as the drive ratings, and that they use interpretation, makes for a lesser degree of independence than exists between drive ratings and behavior ratings. The high correlations between drive and trait ratings presented below will thus have to be viewed with a certain caution. It hardly needs to be emphasized that in briefly discussing the rating procedure and definition of traits with the raters, no reference was made to any possible interrelationships among the traits, or of the traits with the drives or situational behavior. The majority of the results to be presented in this chapter were not anticipated by the author herself.

The inter-rater agreement on these general trait ratings is gen-

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[40] For a justification of defining the traits in a manner as general as has been done here, see Chapter I, Section C, Chapter II, Section C.

TABLE A

Rating List of Traits

Successful adjustment Social prestige Popularity (with same sex) Work adjustment Heterosexual adjustment Personality adjustment	*Adjustment not Successful*
Focus of Interest on Internal Preference for occupation with feelings, fantasies, generalizations, theoretical reflections, artistic conceptions, religious ideas. Withdrawal from practical life.	*On External Activities* Emphasis on practical action and coöperative undertakings. Occupation with outer events.
Security Feelings Self-confident, assured.	*Insecurity Feelings* Inferiority feelings, delusions of unworthiness, inadequacy, weakness. Superiority feelings, delusions of grandeur.
Introspection Self-analysis, self-consciousness, self-criticism, emotional introvert.	*Absence of prolonged Introspection* Emotional extrovert.
Egotism Self-centered, exploiting, self-seeking, self-absorption, Autism, depreciation of others by using them as means to a selfish goal.	*Altruism* Really coöperative and helpful, thoughtfulness of others, really warm object-relations with emphasis on other's benefit.
Creativeness Ingenuity, originality, outstanding personality.	*Mediocrity* Banal, stereotyped or merely sensational, colorless.
Self-sufficiency Does not mind being alone, relative independence of the opinion of others, autonomous.	*Dependence*
Genuineness Direct, true, natural, real.	*Artificiality* Readiness to play rôles, to take postures, masks; clownerie, mannerism; formal, dressed as a "dandy".
Seriousness of Efforts Readiness to make wholehearted efforts.	*Playfulness* Emphasis on having fun, avoidance of serious tensions, seeking amusement and entertainment.
Maturity	*Immaturity*
Strictness of Super-ego Strict conscience	*Laxity*

TABLE 15
INTER-RATER AGREEMENT ON TRAITS

Combination of Judges		Prestige	Successful adjustment				Focus of Interest (Introversion)	Security Feelings	Introspection	Egotism	Creativeness	Self-Sufficiency	Genuineness	Seriousness of Efforts	Maturity	Strictness of Super-ego
			Popularity	Work Adjustment	Heterosexual Adjustment	Personality Adjustment										
FxG	Boys	.84	.72	.55	.77	.53	.59	.67	.49	.41	.53	.38	.51	.37	.39	.42
	Girls	.74	.73	.39	.56	.25	.07	.22	.48	.60	.48	.44	.60	.58	.36	.51
FxH	Boys	.79	.67	.68	.72	.58	.44	.60	.45	.55	.59	.34	.62	.68	.51	.41
	Girls	.67	.67	.52	.69	.59	.02	.36	.30	.52	.39	.37	.47	.55	.63	.47
GxH	Boys	.79	.55	.64	.68	.48	.62	.68	.57	.50	.57	.34	.53	.56	.52	.66
	Girls	.83	.60	.61	.56	.52	.36	.42	.35	.39	.59	.53	.60	.44	.47	.55
Average *r*	Boys	.81	.65	.63	.72	.53	.56	.65	.51	.49	.56	.35	.56	.55	.48	.51
	Girls	.75	.67	.52	.61	.48	.21	.34	.38	.51	.49	.45	.56	.53	.50	.51
Raised *r*	Boys	.93	.85	.84	.89	.77	.79	.85	.76	.74	.79	.62	.79	.79	.73	.76
	Girls	.90	.86	.76	.82	.73	.44	.61	.64	.76	.74	.71	.79	.77	.75	.76

erally quite satisfactory. With a few exceptions the averaged reliabilities computed separately for boys and girls, in a manner analogous to Table 2, range from about .5 to about .8 unraised and from about .75 to .93 raised (Table 15). The exceptions are the following. In girls the unraised reliability for "Focus of Interest" is only .21, for "Security Feelings" only .34, and for "Introspection" only .36. For "Self-Sufficiency" boys show reliabilities of .35 and girls .45 unraised.

The average of all the items is about .6 for boys and about .5 for girls, unraised, and thus somewhat higher than the corresponding values for the drive ratings: .45, .42 (cf. Table 2). The raised averages are in the neighborhood of .8 for boys and .7 for girls.

The average inter-rater agreement on general traits is even higher than that of manifest behavior in specific situations. One reason for this fact may be that trait ratings are more comprehensive than are the short sample behavior observations. An alternative interpretation would be based on the assumption that in a specific situation it is difficult for a judge to isolate the situational element if a broader knowledge about the subject is available. Lower inter-rater agreement could be due to the fact that some raters focus more on the situation, whereas others are inclined to include general impressions.[41]

B. RELATIONSHIPS BETWEEN DRIVE RATINGS AND TRAIT RATINGS

In Table 16 are shown the correlation coefficients between drive ratings and ratings on general traits. The sequence of the drive variables is the same as in Table 12 (showing their relationship with situational behavior).

Autonomy is again omitted on account of its low reliability. Correlations with Autonomy were computed however and were found

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[41] Such an interpretation would be indirectly supported by the findings on perceptual thing-constancy. According to these findings, it is extremely difficult and in many cases impossible to avoid perceiving certain physical dimensions of objects "correctly," in spite of a deliberate attempt to estimate only the impression made on the sense-organ; e.g., we tend to be influenced by the "correct" size of an object even when trying to estimate its projected retinal size. This holds not only for the introspective analysis of immediate perceptual experience, but also for an objective analysis of perceptual achievement by comparing reactions with the physical variables in the environment and in the sense organ (2).

TABLE 16
Raw Correlations between Rated Drives and Rated Traits

		Successful adjustment														
		Prestige	Popularity	Work Adjustment	Heterosexual Adjustment	Personality Adjustment	Focus of Interest (Introversion)	Security Feelings	Introspection	Egotism	Creativeness	Self-Sufficiency	Genuineness	Seriousness of Efforts	Maturity	Strictness of Super-ego
Social Ties	(B)	.20	.01	.01	.36	—.01	—.31	—.09	—.12	.22	.12	—.71	—.40	—.25	—.19	.00
	(G)	—.05	—.14	—.42	—.03	—.26	—.14	—.36	—.27	.22	.07	—.65	—.41	—.41	—.21	—.20
Recognition	(B)	.39	.10	.26	.39	.09	—.10	.02	—.08	.41	.24	—.54	—.42	—.12	—.14	.16
	(G)	.44	.25	.11	.17	.04	—.25	.21	—.03	.67	.50	—.13	—.61	—.36	—.19	—.30
Control	(B)	.30	.18	.16	.29	.11	—.14	.02	—.19	.61	.37	—.30	—.45	—.29	—.08	—.05
	(G)	.37	.16	.20	.14	.12	—.23	.29	—.05	.66	.47	.00	—.59	—.23	—.07	—.29
Aggression	(B)	—.12	—.23	—.52	—.05	—.37	—.20	—.46	—.15	.76	.13	—.53	—.73	—.65	—.40	—.19
	(G)	.27	.06	—.10	.10	—.06	—.12	.01	—.14	.75	.30	—.15	—.65	—.50	—.25	—.36
Escape	(B)	—.27	—.35	—.55	—.17	—.60	—.30	—.56	—.21	.73	—.08	—.59	—.76	—.83	—.58	—.58
	(G)	—.03	—.26	—.46	—.28	—.45	—.08	—.34	—.32	.82	.00	—.40	—.84	—.76	—.57	—.55
Succorance	(B)	—.13	—.37	—.33	—.10	—.46	—.06	—.46	.11	.20	—.32	—.57	—.33	—.32	—.38	—.05
	(G)	—.39	—.52	—.46	—.38	—.57	.01	—.51	—.27	.21	—.45	—.51	—.36	—.36	—.59	—.18
Achievement	(B)	.55	.39	.71	.41	.48	.38	.41	.26	—.07	.42	.13	.19	.59	.37	.46
	(G)	.42	.43	.71	.18	.56	.17	.45	.39	—.11	.64	.41	.02	.52	.45	.47
Abasement	(B)	—.49	—.38	—.55	—.40	—.52	.17	—.62	.46	—.21	—.18	—.12	.01	—.10	—.21	.31
	(G)	—.45	—.33	—.31	—.25	—.38	.25	—.53	.09	—.53	—.37	—.28	.24	.12	.02	.21

never to exceed .38; the latter holds for "creativeness" in boys. The lowest negative figure is —.34, with "Genuineness" in girls.

We begin the discussion of Table 16 with the pair of rows describing the trait relationships with ratings on Aggression. With the five adjustment items correlations are slightly negative in boys, and close to zero in girls. There is a negative relationship for boys, —.46, between Aggression and "Security Feelings." This value is somewhat in contrast with the slightly positive relationship of Aggression with the situation item "social self-confidence," .29, and with "self-assertion," .64 (see Table 12). This points toward the difference between "behavior" and "traits," the former describing social techniques, the latter more final adjustment. Aggressive boys thus may be fundamentally insecure in spite of the fact that they tend to display symptoms of security. In girls, however, there is no correlation between Aggression and "Security Feelings." The highest correlation of Aggression is with "Egotism" (around .75 for boys and girls). The highest of the negative correlations is with "Genuineness" (about —.70 for both boys and girls). Relationships with "Seriousness of Effort," "Maturity," "Self-Sufficiency," and "Strictness of Super-ego" are likewise negative. It thus may be said that the aggressive person appears in a much less favorable light when viewed in terms of general traits than when viewed in terms of responses limited to a situation.

A pattern quite similar to that of Aggression is shown by Escape. The main differences are that relationships to the five adjustment items as well as to "Security," "Genuineness," "Seriousness of Efforts," "Maturity," "Self-Sufficiency," and "Strictness of Super-ego" are more clearly negative for both boys and girls than in the case of Aggression. The highest negative value in the entire table, —.84, is obtained for girls between Escape and "Genuineness" and a very similar one for boys between Escape and "Seriousness of Efforts." With "Egotism" there is again a high positive relationship which reaches .82 in girls.

The drives for Recognition and Control, on the other hand, show a slight trend toward positive relationships with the five adjustment items. Otherwise they are quite similar to Aggression with a tendency below the level of significance throughout, toward the favorable traits and away from "Egotism." With Social Ties correlations are generally close to zero with the major exception of "Self-Sufficiency" which correlates negatively, close to —.7 for both boys and girls.

The most important finding in Table 16 is the fact that the three remaining drive variables—Achievement, Abasement, and Succorance—which did not show close relationships to situational behavior, correlate to a considerable extent with a number of general traits. Since, as will be shown in the next chapter, these three drives correlate better than any of the others with the children's self-reports, it is especially desirable to have some reference items for these drives on the surface level.

Ratings on the drive for Achievement show a general picture opposite to Aggression and Escape. All relations are positive with the exception of those with "Egotism." Coefficients are close to zero on the negative side for this item, whereas they have been found to be highly positive in the case of Aggression and Escape. The highest positive relationships are with "Work Adjustment," .71 for both boys and girls. The remaining four adjustment items are likewise well on the positive side with the one exception of "Heterosexual Adjustment" in girls. Persons striving for Achievement besides being popular, having prestige, and being adjusted to their personality and work, are characterized by some tendency to be introvert and introspective, secure, creative, serious in their efforts, mature, endowed with a strict super-ego. As mentioned in Chapter VI the picture of individuals rating high on Achievement emerges in this manner: responsibilities are well assimilated and internalized due, probably, to freedom from emotional conflicts. Neither open nor concealed mechanisms of Escape or Aggression can be found.

Abasement shares, with Aggression and Escape, the negative relations to the adjustment items as well as to "Security Feelings." In fact negative correlations with these items are more marked (up to —.62) for Abasement than for any of the other drive variables. A similarity to Achievement is, however, suggested by the fact that correlations with "Egotism" are negative and reach —.53 in girls. Furthermore, Achievement and Abasement are the only two drive variables which do not show negative relationships with "Genuineness" and have positive relationships with "Strictness of super-ego." Though on the whole maladjusted, especially in the social sense, Abasement seems to go or at least to be compatible with such "moral" qualities as unselfishness and strictness of super-ego. Aggression and Escape on the other hand show an inverse relationship to the moral qualities mentioned.

The last drive variable which remains to be discussed is Succorance. Coefficients are almost exclusively negative with the exception of "Egotism," which is the only distinctly maladjusted trait in our list. Succorance thus is as consistently maladjusted as was Escape, though to a decidedly lesser degree, and, for most items, below the level of significance. This is especially noteworthy in view of the fact that Succorance did not show correlations with Escape and Aggression, nor did it show similar behavior profiles. Their similarity, suggested by the psychoanalytic assumption that Succorance as well as Aggression and Escape are regressive tendencies, is thus brought out only in their relationships to the traits. One can easily see how individuals with strong Aggression would behave differently or even in an opposite way from individuals with strong Succorance in social situations. Yet in the end they both will be characterized by the same absence of real adjustment to society and to work, as well as by the failure to attain a developed, mature personality.

It will be noted that the sexes are more alike in correlations between drives and traits than in correlations between drives and situational behavior. Only exceptionally do we find sex differences in Table 16 which approach significance. It thus seems that the expression of motivational patterns show greater differences between the sexes where social techniques are concerned than where the more lasting effects of behavior are concerned.

C. ALTERNATIVE TRAIT MANIFESTATIONS OF DRIVES AS REPRESENTED BY MULTIPLE CORRELATIONS

As in the preceding chapter the question can again be raised as to the presence of patterns of alternative expressions. This time, however, we are considering alternative expression in general traits rather than in specific behavior. For each drive a list of traits correlating with it more than ±.30 was made for boys and girls separately. The attempt was then made to divide these traits on psychological grounds into sub-types which might be expected to represent alternate manifestations or symptoms of the drive in question. The general psychological hypothesis was that many of the drives might be expected to have both well adjusted and maladjusted expressions among the traits.

As will be recalled, intercorrelations between traits are required in an analysis of alternative manifestations, with those combinations being most fruitful which show a great amount of independence or even an inverse relationship. A complete chart of inter-item correlations on general traits was thus prepared as an auxiliary. Those cross-correlations are not presented here in detail. They cover a wide range from .87 to —.80. High correlations are, however, limited to a relatively small number of combinations of items, especially in the adjustment group, e.g., between "Popularity" and "Prestige," "Personality Adjustment" and "Security Feelings," "Genuineness" and lack of "Egotism," and the like. The majority of the inter-item correlations are close to zero or very low, so that there was a wide array of combinations to pool from for purposes of analyzing alternative manifestations. Multiple correlations were then calculated between two traits correlating at least .3 with the drive under consideration, utilizing all of the pairings consistent with the hypothesis. In most cases cross-correlations between the two traits were sufficiently low to make the multiple correlation technique fruitful.

Among the patterns of alternative manifestations, those turn out to be most interesting which relate to some of the drive variables which did not show very clear relationship to situational social behavior. This is especially true for the drive for Abasement. In girls Abasement correlates .53 with both "Altruism" and "Insecurity Feelings" whereas the intercorrelations between these two traits is zero.[42] The joint correlation with ratings on Abasement is .75. Thus girls tending toward Abasement seem to have the choice between sublimating their Abasement in altruism, or being insecure. Similarly high values of multiple correlations have been obtained when insecurity was replaced by the related items, lack of "Prestige," "Personal Maladjustment," and "Bad Working Habits," though the zero order correlations between these traits and Abasement range only from .31 to .45. Thus girls with high ratings on Abasement seem to be either altruistic and/or maladjusted.

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[42] The terms used to characterize these two traits are the converse of our item names egotism and security feelings and were introduced to avoid the negative signs of the correlations.

For boys tending toward Abasement there is a quite different alternative. A number of maladjusted traits such as "Insecurity Feelings," "Bad Working Habits," and to some extent "Personality Maladjustment" and "Lack of Prestige" are alternates for "Strength of the Super-ego." The multiple correlations are, in the sequence of maladjusted traits given above, .72, .80, .68, .65. They are based upon zero-order coefficients of .62, .55, .52, .49, respectively, in combination with a coefficient of only .31, characterizing the relationship between Abasement and "Strength of the Super-ego." The reason for the unusually great gains in some of the instances over the zero order coefficients lies in the fact that intercorrelations of the various maladjusted traits with "Super-ego" are all negative. This is especially true for "Bad Working Habits" and "Super-ego" which correlate —.40, so that there is a difference of .25 between the higher of the two correlations with Abasement (.55 and .31) and the multiple coefficient of .80. In other words a strong "Super-ego" and "Bad Work Adjustment" are not merely independent but to some extent even incompatible. The alternative relationship between various forms of maladjustment on the one hand and "Strictness of Super-ego" on the other, with Abasement in boys thus assumes to some extent the character of an exclusive either-or relationship rather than being a relationship of the and/or type. A possible interpretation of this might be that the maladjusted traits listed above play the rôle of masochistic outlets in relation to the social environment in boys rating high on Abasement. It then could be said that such boys either succumb to their associates or to their own conscience, with an emphasis upon the fact that both alternatives mean submission, not mastery or ascendance of the ego. The fact that in girls an adjustment can more readily be made by devotion to other people, whereas in boys it is made by means of self-discipline and devotion to moral principles, is something which seems to follow from the popularly assumed and assigned rôles of the sexes in our society.

With respect to the drive for Achievement, the alternatives are as follows: "Introspection" (girls), and "Introversion" (focus of interest) (boys), on the one hand, and "Work Adjustment," "Personality Adjustment," "Social Prestige," "Security Feelings," and "Popularity" on the other. The latter items are arranged in a decreasing order of magnitude of multiple correlations, a sequence which is approximately the same for boys and girls with multiple correlations ranging from .74 to .51. The alternative thus seems to be, for subjects striving toward Achievement, either effective adjustment to work and society or to be turned inward. In boys this turning inward seems to take, at least in part, the form of an occupation with generalizations, theoretical reflections, artistic and religious conceptions; whereas the preferred form in girls stresses more the emotional side of introversion as represented by prolonged self-analysis, self-consciousness, and self-criticism (see the above definitions of "general traits").

As a third drive variable let us consider Recognition. For girls there are the alternatives of "Prestige" and "Creativeness" on the one hand, and/or "Egotism," "Artificiality" (the opposite to "Genuineness"), "Playfuness," (the opposite to "Seriousness of Effort") and "Weakness of the Super-ego," on the other. Multiple coefficients are considerably higher for these combinations than they were for those characterizing Achievement. The highest coefficient in this entire type of comparison, .87, is obtained between Recognition and "Prestige" and/or "Egotism." It is based on zero order coefficients of .44 and .67, with an intercorrelation between prestige and egotism of —.16. The alternatives of "Creativeness" and/or "Egotism," and "Creativeness" and/or "Artificiality" are likewise characterized by multiple coefficients above .8. The only coefficients in this group which are not close to at least .7 are those for "Prestige" and/or "Playfulness" and for "Prestige" and/or "Weak Super-ego." They are .58 and .62, quite in contrast to the zero order coefficients which are only .44 and .36 and .44 and .30 respectively. In the latter case the cross-correlation between the trait is, however, well on the negative side, —.27, indicating a slight degree of incompatibility between "Prestige" and "Weak Super-ego" in girls, though below the level of significance. "Creativeness" and "Weak Super-ego" as well as "Creativeness" and "Playfulness" show a similar slight tendency toward incompatibility in girls (—.28, —.27) raising the higher of the zero order coefficients, .50 between Recognition and "Creativeness" to .68 and .72 respectively.

The corresponding alternatives for Recognition in boys, and the multiple correlations, are: "Prestige" and/or "Dependence" (opposite to "Self-sufficiency") .70, "Prestige" and/or "Artificiality" .63, and "Prestige" and/or "Egotism" .60. The increments over the zero order coefficients are again quite marked, due to the fact that all the three cross-correlations are negative, —.11, —.18, —.12. With the same three items there also is an alternative relationship with "Heterosexual Adjustment," with multiple coefficients between .60 and .66.

It thus can be said that both boys and girls seem to need "Prestige" when striving for Recognition. Otherwise they are likely to develop such maladjusted traits as "Egotism" or "Artificiality."

Similar alternative trait-patterns to those for Recognition, but quantitatively not quite as clear, were also obtained for Control, with the exception that on the adjusted side we find "Prestige" and "Creativeness" for both girls and boys. For Escape, an extended list of maladjusted features stands in alternative relationship with "Extroversion" in boys and lack of "Introspection" in girls (see the above discussion of Achievement).

Due to the fact that Aggression appears to represent thoroughly maladjusted behavior, it shows no clear patterns of adjusted versus maladjusted alternative manifestations. It will be remembered that, in contrast to this, Aggression had shown alternative relationship with emotional maladjustment as one alternative, and certain elements of adjusted overt social activity as the other alternative. As mentioned above, Aggression, though apparently contributing to social activity, shows negative relations to adjustment in a more intrinsic sense.

Like Aggression, Succorance also does not admit an alternative adjusted manifestation on the level of general traits.

D. First Order and Higher Order Multiple Correlations between Traits and Two or More Rated Drives

In analogy to Chapter VII, ambiguous relationships will now be considered in the opposite direction, namely, from one general trait to the several drives it may be tied to or determined by. Unlike the previous discussions, higher order multiple correlations will also be discussed as computed between one trait and more than two drives in the latter part of this section.

Among the first order multiple correlations we mention only

"Dependence" (the opposite to "Self-Sufficiency") which shows in boys a multiple correlation of .81 with Social Ties and Escape, and of .72 with Aggression and Succorance. The basic correlations can be found in Tables 16 and 10.

Furthermore, "Seriousness of Efforts" shows in boys a multiple correlation of .84 with Achievement and/or the absence of Aggression and of .88 with Achievement and/or the absence of Escape. The corresponding figures for girls are .76 and .85. Readiness to make an honest effort without slipping into pseudo-solutions seems thus to spring from various apparently rather independent sources such as a direct interest in Achievement or a lack of Aggression (which probably interferes with concentration) and a tendency to stand firm in the face of hard work and postponement of pleasure reward (see the definition of our drive variables, Chapter II).

Multiple correlations with the general trait "Strictness of the Super-ego" are similar to the multiple correlation with "Seriousness of Effort" (which correlates around .7 for both boys and girls with strict super-ego). In girls the "Strength of the Super-ego" correlates .66 with Achievement and/or the absence of Escape, raised from .47 and —.55. The conditions under which a strong super-ego is built up, at least in girls, is described by the above correlates of that trait. In boys considerable increase in correlations is obtained when each of these two drive variables, Achievement and absence of Escape are teamed with Abasement, resulting in multiple correlations of .65 and .52 respectively. Thus, apparently as an alternative to Achievement and absence of Escape, Abasement may be used in the building up of a moral attitude.

To conclude, relationships with more than two drive variables at a time will now be discussed for ratings on the following general traits: "Maturity," "Security," and "Personality Adjustment." The significance of the gains in correlations obtained by including one more drive variable was tested by the Wherry shrinkage formula. Only such cases will be discussed in which the gains are significant. Higher order multiple correlations computed for a number of other promising instances were not found to fulfill this criterion and are therefore omitted here along with other instances in which the gains are rather inconspicuous.

A second order multiple coefficient of .72 was obtained by correlating "Maturity" with Achievement, lack of Escape and lack of Succorance, whereas the first order multiple correlation prior to adding Succorance was .67. In boys a similar combination, with Escape replaced by Aggression, was found to raise a first order multiple correlation of .52 to a second order coefficient of .64. These instances showing comparatively small gains are quoted primarily because of their psychological interest.

For the general trait "Insecurity" (the opposite of "Security feelings") combinations of Abasement, Succorance, absence of Achievement, and Escape in girls and Aggression in boys yield third order multiple coefficients of .78 for girls and .83 for boys. In girls none of the basic coefficients surpass .53 and in boys none of them surpass .62, as can be seen in Table 16.

For both boys and girls "Personality Maladjustment" yields third order multiple coefficients of .79 for the joint correlation with an almost identical combination, Abasement, Succorance, Escape, and absence of Achievement.

Thus it may be said that a rather wide variety of relatively independent motivational tendencies, such as the drive for Abasement, for Achievement, for Succorance, and for Aggression, and for Escape, seems (as far as ratings are concerned) to contribute in an and/or fashion, toward the formation of a number of traits relevant to adjustment such as "Personality Adjustment," "Security Feelings," "Maturity," "Strictness of Super-ego," and "Seriousness of Effort."

One of the most important conclusions to be drawn from Chapters VII and VIII is that the relations between motivational tendencies, on the one hand, and manifestations of situational, social behavior and general traits, on the other are ambiguous and complex, but that these tangled relationships can be specified and made explicit. Not only does one drive seem to circumscribe a family of alternative manifestations which are more or less independent of each other, but one overt expression or adjustment may also be linked to several alternative underlying tendencies.

IX. THE MEANING OF THE ADJUSTMENT INVENTORY (SELF-REPORTS) IN TERMS OF RATINGS OF SITUATIONAL BEHAVIOR, DRIVES, AND TRAITS[18]

A. Comparison of Drive Ratings with Independent Data

In the preceding six chapters statistical relationships between various kinds of ratings were discussed. Chapters III to V dealt with interrelationships within our drive ratings, both between raters and between variables. Chapters VI to VIII dealt with relationships between drive ratings and ratings purporting to refer to functionally different levels, based in part, at least, in Chapters VI and VII, on the observations of different raters. Yet the fact that these data were ratings introduced a sort of dependence between the sets of data compared. Thus up to this point no definite answer could be given to the question as to whether the relationships found are based on objective facts or are merely reflections of what goes on in the minds of the raters—as individuals or as a group, explicitly or implicitly—when they make their ratings. To be sure, there was ample evidence of the plausibility of our results in terms of widely accepted clinical and analytic insight. For many this might be sufficient proof of the fact that the results pertain primarily to *the children rather than to the raters*. However, *the crucial test* remains whether or not such ratings will yield successful predictions about reactions of the children other than those reactions which have influenced or could have influenced the ratings under consideration.

This and the following chapter deal with the relations of the drive ratings and the other types of ratings to materials from such independent sources. In this chapter children's self-reports ("Adjustment Inventory") will be compared with the three kinds of ratings referred to in this study thus far. A variety of other sources, including projective material, will be utilized briefly in Chapter X.

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[18] The results discussed in this chapter will be reported in greater detail in a forthcoming publication, *Contributions to the Validation of the Adjustment Inventory*.

B. Relationship between Adjustment Inventory and Situational Behavior

As we pointed out in the Introduction, the results of studies dealing with the agreement between self-reports, as given for example in the "Adjustment Inventory," and corresponding ratings of behavior in social situations, were on the whole rather discouraging.[44]

The "Adjustment Inventory" used by the California Adolescence Study consists of about 270 questions, and was given to the entire adolescence study group twice a year over a period of eight years. The questions are designed to make the children reveal, directly or indirectly, their attitudes toward issues relevant for adjustment.[45]

Correlations between total adjustment scores[46] and social situational ratings were computed by Carolyn McC. Tryon for the grades seven and eight. The correlations were found to range from about zero to .3.

Brief mention will be made here of the results of some additional attempts by the present writer to throw light upon the meaning of the adjustment inventory data by comparing them with social situation ratings. Correlations were computed, first for directly corresponding broad categories of data (such as social adjustment as revealed by the self-reports versus social adjustment as rated by the staff members) and also for corresponding single items (such as self-report of the subject on the question about being popular, and the "popularity" rating based on observations by the raters). Second, correlations were also computed for promising pairs of items in the adjustment inventory and the situational rating list which did

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[44] A summary of the results obtained by various authors is given by Vernon.

[45] Typical questions from various portions of the Inventory are:

A. is a boy who seems to have a lot of fun. Am I just like him? Do I wish to be just like him? (Direct question)

N. is a boy who is unhappy a good deal of the time because he thinks no one likes him. Am I just like him? Do I wish to be like him?

Do you think you are a rather nervous person? (Direct question)

I wish my father were more cheerful. (Indirect question.) For further reference about the Inventory used in the Adolescent Growth Study see Caroline McC. Tryon, A Study of Social and Emotional Adjustment: *The Internal Consistency and Inter-relationship of Measurements by Different Techniques*, Ph.D. Dissertation, Univ. of Calif., 1935 (unpublished).

[46] The procedure of obtaining these total scores is based on a classification by a group of staff members of the California Adolescence Study, of each item on the list as being indicative (with greater or lesser weight) of adjustment or maladjustment (see C. McC. Tryon).

not directly correspond in wording or in meaning (for example, the number of fears admitted by the subject and "personal inferiority" as rated by the judges in social situations).

Approximately 250 coefficients were computed for the total group. Though there is on the whole a positive trend, the coefficients are rather low and even the extreme values are not quite significant; that is, they do not indicate with any certainty the existence of a *relationship between self-reports and objectively rated behavior in* specific situations.

In a few of the most direct items, however, a trend toward a "curvilinear" relationship seems to be present. For example, individuals rated most unpopular as well as those rated most popular showed a tendency to characterize themselves as being extremely well-adjusted in the corresponding adjustment inventory item (about one's popularity) whereas the intermediate cases on the whole were ready to admit some degree of imperfection. In other words, in the case of those most direct questions, it is the person who is very maladjusted in the opinion of adults who shows the greatest tendency toward self-deception. The fact that individuals who are rated very maladjusted describe themselves as very well adjusted when directly asked may be taken as an example of a defense mechanism (i.e., denial).[47] Though the significance of the curvilinear tendency is not definitely secured, there is sufficient indication in our data to warrant being on the alert for the possibility of important curvilinear relationships in the quantitative analysis of some kinds of data in the field of personality.[48]

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[47] Another approach to the problem of self-deception consisted in determining indices of insight into one's own personality for each subject on certain behavioral items (such as "tenseness") by computing the difference between the *sigma scores of the rating assigned by the raters and the* self-report scores from the adjustment inventory on the same item. These indices were then correlated with some other behavior ratings, e.g. sociability. The coefficients obtained were in some cases rather high (e.g., .64 between self-deception on tenseness and social maladjustment as rated by adults). Though it is perfectly correct to say, because of these coefficients that persons having no insight into their tenseness are also likely to be maladjusted, there is nevertheless a spurious element in these correlations resulting from the fact that a function of a variable is correlated with the variable itself or as in our case with a closely related variable. A correction specially developed (by Dr. Herbert S. Conrad) to eliminate this element of spuriousness reduced most of the correlations to almost zero, indicating the absence of relationship between adjustment inventory items and social behavior when the interrelationship between the two ratings of social behavior which enters the complex (tenseness and social adjustment) is eliminated. In a study on "Mechanisms of self-deception" (*J. Soc. Psychol.*, 1939, **10**, 409-420) by the *present writer, similarly high correlations between self-deception and certain* other personality traits were reported based on material collected in collaboration with S. Nagler at the Psychological Institute of the University of Vienna. The pattern of the problem being similar to the one just discussed, the same criticism of the spuriousness of some of the results should have been applied.

C. RELATIONSHIPS BETWEEN ADJUSTMENT INVENTORY AND RATED DRIVES

There remains the possibility that the self-reports might represent certain inner dynamic states, or, more generally, certain personality constants, rather than directly overt behavior or status with respect to the group in those situations in which the ratings were made.[49] This expectation is supported by the fact that during preliminary studies of the material of the Adolescence Study, the present writer gained the impression that the responses on the Adjustment Inventory might be tied quite closely to the free qualitative comments which had been put down from time to time by the staff members. These comments besides describing the behavior and attained status of the children, also referred to the "importance" these facts have for the personalities of the children from a motivational standpoint.

In the analysis which follows, only total scores on the Adjustment Inventory are used. The Adjustment Inventory data are those for the years when the children were in the eleventh and twelfth grades, the last two years in which the adjustment questionnaire was given. The sources of the two sets of data are completely independent, since none of the staff members who participated in the drive ratings were familiar with the scores of this group of children on the adjustment inventory.

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[48] The present writer has not investigated these possibilities in detail. Among the few correlations of this kind computed, the following may be quoted. In an effort to test psychoanalytic assumptions about the "oral type," correlations were computed between food difficulties in early childhood as reported by the mothers in the course of a routine interview of the parents, and talkativeness in adolescence as rated in social situations. The linear correlation was around zero. An inspection of the scatter diagrams indicated a curvilinear relationship. The subsequently computed correlations between food difficulties in early childhood and the degree of deviation (either up or down) from *average* talkativeness, turned out to be .59 for our group of boys.

[49] Thus our program carries out what has been postulated by Stagner (17) in the following quotation, "We cannot surgically lay bare the 'inner personality' and compare its organization with the results of the test. Only indirect inferences are possible." The "inferences" are here represented by our drive ratings and the "test" by the Adjustment Inventory.

TABLE 17

CORRELATIONS BETWEEN TOTAL SCORE ON ADJUSTMENT INVENTORY (SELF-REPORTS) AND RATED DRIVES

(Raw correlations; values corrected for attenuation are in parentheses.)

	Boys		Girls	
Grade:	11	12	11	12
Social Ties	—.14	—.07	—.19	—.34
Recognition	—.12	—.13	—.13	—.11
Control	.19	.09	—.02	—.02
Aggression	—.10	—.12	—.17	—.31
Escape	—.10	—.16	—.27	—.33
Succorance	—.43 (—.57)	—.34 (—.45)	—.07	—.17
Achievement	.01	—.02	.47 (.59)	.40 (.50)
Abasement	—.51 (—.66)	—.45 (—.58)	—.15	—.23

Table 17 presents the results of this analysis. To simplify the discussion, the sequence of the drive variables is again the same as that used from Chapter VI on. The figures indicate raw correlation coefficients between adjustment, in terms of the self-reports and the rated strength of each drive. They are based on about 45 boys and 40 girls, with slight variations in number up and down, for the two years. For the significant correlations, the values obtained by correcting for attenuation are given in parentheses.

For the first five drives in the rearranged list, correlations of the Adjustment Inventory are mostly negative, though in no case significant. The almost consistent negative trend may be taken as an indication of the fact that these drives tend to vary not only with maladjustment in behavior but also with maladjustment in the more subjective realm of self-reports.

There are, however, some significant correlations for the last three drive items, though in no case for both sexes. It will be remembered that only the first five drives showed fairly close relationships with behavior in social situations, whereas the last three did not (see Chapter VI). Thus it appears that there are two different sets of drives, one of which shows relations to social behavior while the other shows (among either boys or girls) relationships to self-reports. This is a further indication of the independence of the two aspects of personality: social behavior and self-reports.

Particularly for boys, there is a significant negative correlation of the ratings in Abasement and Succorance with the Adjustment Inventory score for both years, around —.6 and —.5 raised. This indicates that the rated tendency to abase oneself, to "admit inferiority and defeat" (see the definitions of drives in Chapter II), and to long for support, tends in the case of boys to be reflected in describing or indirectly revealing oneself as maladjusted on a self-report inventory. This questionnaire may thus be said to possess some diagnostic value, since it shows a relationship to dynamic conditions which were rated on the basis of long-range behavior observations. According to general clinical knowledge, we would expect the presence of Succorance and Abasement to lead to admission of failure. Boys high on Aggression or Recognition quite often do not admit maladjustment even if rated high on it (see next section). The adjustment inventory thus does measure some types of maladjustment in boys but not all types.[50]

The results for girls differ in several ways from those for boys. For them the correlations between Adjustment Inventory score and Abasement and Succorance are not significant. As we suggested from the analogous data of Chapter VI, Abasement and Succorance should neither lead to, nor be symptoms of, maladjustment in girls as frequently as in boys. The only relationship which is significant in girls for both years is a positive correlation of .47 and .40 unraised, or .59 and .50 raised, with Achievement, a trend which is absent in boys. In checking up on this relationship it was discovered that the correlation between the Adjustment Inventory score of 1933 and the rating on Achievement was even higher, namely, .59 unraised and about .7 raised. Girls who put emphasis upon Achievement thus consistently tend to present themselves as well-adjusted in terms of the Adjustment Inventory. (Maladjustment, even if it should be present, would be denied and camouflaged even in the more subtle expressions of maladjustment contained in the

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[50] Our results are in line with the conclusions arrived at by various authors with respect to the Adjustment Inventory. Donald E. Super (19) concludes on the basis of the literature that the Inventory is of little practical value in selecting behavior problem cases. Landis and Katz (11) conclude that a clinical diagnosis of neurosis has no significant relationships to the Adjustment Inventory test. Our analysis of the test may contribute to an understanding of these results. The Adjustment Inventory measures to a certain degree (in boys) tendencies for self-abasement and tendencies to lean on others (Succorance). Neurotic tendencies related to other motivational situations will not be admitted and will even be compensated for on the self-report tests. Hence no significant relationships are found between maladjustment and self-reported maladjustment.

Adjustment Inventory.) However, it might be that in girls the tendency to achieve, as rated by observers, and to emphasize their own strength in the questionnaire, are parallel consequences of a common and more remote factor, e.g., masculine identification.

In commenting on these results, we may point to the fact that Achievement has been found to be correlated predominantly with manifest features which have to be classified as adjusted, whereas Succorance and Abasement showed a closer relationship to overt maladjustment. Hence we may understand that adjustment in terms of the self-report inventory shows positive correlations with Achievement and negative correlations with Succorance and Abasement. However, the fact that the correlation with Achievement exists only for girls, and the relationships with Succorance and Abasement hold only for boys, still needs explanation. One could point toward the fact that Succorance and Abasement are, in our culture, predominantly feminine tendencies and therefore make boys rating high on these tendencies more self-conscious and more disturbed in questions of adjustment. On the other hand, girls striving for the more masculine ideal of Achievement may feel they have more reason to display signs of a good adjustment.

In any case the fact remains that in both boys and girls, Adjustment Inventory scores show significant correlations with drives which usually are considered, in our culture, characteristic of the opposite sex.

In interpreting these results it must be kept in mind that the meaning of the drive ratings had to remain vague as long as they were not anchored in some directly observable material and thus are operationally defined. The preceding chapters represent an attempt to furnish such a frame of reference. It has been mentioned already that situational behavior is of no great help in clarifying the meaning of those drives which show correlations with the Adjustment Inventory. Much more is achieved when relationships between drives and general behavior traits are considered.

In particular, the drive variables Succorance and Abasement which correlate with the Adjustment Inventory for boys, have been found in Chapter VI, Table 12, to correlate only very slightly with the 33 items of behavior in social situations. For Succorance none of the 33 coefficients reaches .4. The only two coefficients in the thirties indicate a slight relationship, though below the level of significance, with tenseness (.35) and with dependence on approval (.31). For Abasement there are a few (three) coefficients above .4, but none of them is higher than .46. The latter is the value which characterizes the relationship to being dissatisfied, and the next, —.42, indicates the absence of smooth social functioning. However low, these correlations point toward the behaviorally maladjusted side of the two drive variables, which is also reflected in negative correlation with the Adjustment Inventory.

Such a trend is revealed much more clearly in the correlations of Abasement and Succorance in boys with the general traits discussed in the preceding chapter and presented in Table 16. For Succorance, the highest coefficient is —.57, indicating absence of self-sufficiency. Other significant negative correlations are with personality adjustment and security feelings as well as with maturity and popularity. For Abasement there likewise is a sizeable negative relation with security feelings (—.62). Furthermore all five correlations with successful adjustment are negative, ranging up to —.55, and there is a positive correlation of .46 with Introspection. Though in different ways, both Succorance and Abasement clearly reveal a maladjustment side as far as general behavioral traits are concerned.

The drive for Achievement, which shows a positive relationship for girls with Adjustment Inventory, does not correlate more than —.39 for the 33 items of situational social behavior. This suggests that those having a strong drive for achievement are not dependent on social approval in immediate social situations. With general traits, however, closer relationships can be found. The drive for Achievement correlates .71 with good work adjustment, .64 with creativeness, significantly high with various other "favorable" traits. The relationships between adjustment as revealed by self-reports and adjustment in terms of general behavioral manifestations have here been discussed in an indirect fashion, using two correlational steps with rated drives as the intermediate link. Though reference to drives and motivation may ultimately have no value except as an intermediate between two or more sets of directly observable data, their rôle as an intermediate link should not remain unquestioned either. In other words, indirect relationships such as those discussed here should not be accepted without being checked by direct correlations, since it is quite possible that the latter may be very low in spite of the fact that each of the two *intermediate steps* is characterized by a significant coefficient. By applying a direct check, rated drives would then serve as a stimulating heuristic influence. In the next section we will discuss the direct relationships between the Adjustment Inventory and general traits, and discover what general traits, correlating with the drives for Succorance and Abasement in boys and Achievement in girls correlate directly with the self-reports.

D. ADJUSTMENT INVENTORY AND RATED TRAITS

An attempt to relate traits directly to the Adjustment Inventory is shown in Table 18. The relationships of the 15 traits with the adjustment on the Adjustment Inventory are presented, for boys and girls, for 1937 and 1938. Coefficients corrected for attenuation are also presented.

TABLE 18

CORRELATIONS BETWEEN TOTAL SCORE ON ADJUSTMENT INVENTORY (SELF-REPORTS) AND GENERAL TRAITS

	Raw Coefficients				*Coefficients corrected for attenuation*			
	Boys		Girls		Boys		Girls	
Grade:	11	12	11	12	11	12	11	12
Prestige	.34	.26	.33	.27	.37	.29	.36	.30
Popularity	.36	.38	.31	.31	.41	.44	.35	.35
Work Adjustment	.19	.20	.52	.60	.22	.23	.62	.72
Heterosexual Adjustment	.26	.27	.12	.17	.29	.30	.14	.20
Personality Adjustment	.28	.33	.51	.51	.34	.40	.62	.62
Focus of Interest (Introversion)	—.22	—.42	.08	.18	—.26	—.50	.13	.28
Security Feeling	.45	.45	.43	.48	.52	.52	.57	.64
Introspection	—.43	—.57	.04	.31	—.52	—.69	.05	.40
Egotism	—.04	.16	—.23	—.28	—.05	.20	—.28	—.33
Creativeness	.01	—.17	.07	.15	.01	—.20	.08	.18
Self-Sufficiency	.20	.16	.30	.56	.27	.22	.37	.69
Genuineness	.14	.14	.19	.30	.17	.17	.22	.35
Seriousness of Efforts	—.01	—.06	.38	.54	—.01	—.07	.45	.64
Maturity	.16	.17	.18	.27	.20	.21	.22	.32
Strictness of Super-ego	—.32	—.37	.37	.47	—.39	—.45	.44	.56

The general trends are the same for both years, but there are striking differences between boys and girls.

For boys, among the significant correlations (i.e., raw coefficients of at least .4) we may call attention first to the negative relationship between adjustment scores and "Introspection" as rated by observers (—.43 for the eleventh grade and —.57 for the twelfth). This is in line with the fact that a positive relationship was found between "Introspection" and Abasement, the latter being in its turn related negatively to the adjustment score on the Inventory.

Boys rated as "Secure" present themselves as adjusted on the Adjustment Inventory, as shown by a raw correlation of .45 (for both grades) in agreement with the high negative correlation between Abasement and "Security" mentioned above.

Furthermore, there is a slight negative relationship, —.32 for the eleventh grade and —.37 for the twelfth, between the self-reported adjustment score and the observer ratings of "Strictness of the Super-ego" or "Conscience" for boys.

It is remarkable that the ratings based on the attempt at a direct objective approach to adjustment show only a slightly positive correlation with the subjective expression of adjustment in the Adjustment Inventory for boys. We may understand this when we remember that maladjustment as a rated trait correlated not only with Abasement and Succorance in boys but also with some other dynamic tendencies such as Aggression and Escape. As mentioned above (Section B of this chapter) it is apparently only one group of these alternative causes for maladjustment, namely, the Abasement, Succorance complex, which determines scores on the Adjustment Inventory. In other words, boys high on Aggression[51] and Escape will be maladjusted in the opinion of observers but will not specifically tend to present themselves as maladjusted on their self-reports, whereas boys high on Abasement and Succorance will also be maladjusted but at the same time will not be able or inclined to hide their maladjustment in the self-reports. We may conclude from this that explicit reference to the motivational level may play a definite rôle in organizing data and uncovering relationships in a manner which goes beyond its function as a mere intermediate link.

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[51] Self-reports measure Abasement but not Aggression. Aggressive drives, however, can be measured by tests which involve critical judgments of other people and of social customs rather than of oneself. Mary C. Jones found a correlation of .48 (corrected to .65) between drive for Aggression and tests measuring attitudes toward conduct and social customs (for the same group of boys).

As far as the girls are concerned, results of the previous section seem to indicate a correlation between a high subjective adjustment score on the Inventory and a high rating on the drive for Achievement, whether this drive be genuine or in the nature of a compensatory adjustment. From Chapter VIII we learned that there is a correlation between the drive for Achievement and several adjustment traits. From Table 18 we may add that there also is a positive relationship for girls between the adjustment score on the Inventory, and the trait "Work Adjustment" (.52 for the eleventh and .60 for the twelfth grade, unraised), and with "Personality Adjustment" (.51 for both grades). Girls rating high on Achievement also show much "Prestige," although "Prestige" does not enter as a strongly related factor on the Adjustment Inventory.

Furthermore, there is in girls a positive correlation between "Seriousness of Effort" and "Self-sufficiency" as rated by adults, and good adjustment as reported in the self-descriptions of .38 and .54 and of .30 and .56, unraised, for the eleventh and twelfth grades respectively.

Unlike the boys, "Introspection" is found in girls to show a slight positive relationship (.31) with the adjustment score on the Inventory, at least as far as the twelfth grade data are concerned. Likewise, "Strict Conscience" seems to go with a positive adjustment on the Inventory in girls, whereas in boys this relationship tends in the opposite direction (.37 and .47 for girls, —.32 and —.37 for boys). This contradiction can be understood by referring to Table 16 in Chapter VIII. "Strict Conscience" correlates positively with both Abasement and Achievement. Since Abasement for boys is negatively related to adjustment on the Inventory, and since Achievement for girls is positively related, we should expect to find "Strictness of Super-ego" in boys negatively and in girls positively related to self-reported adjustment. The same holds true for "Introspection." Since "Introspection" is also related to both Abasement and Achievement, we find it related positively for boys, and negatively for girls, to adjustment as measured by the inventory.

The only significant relationship which girls and boys have in common is that between ratings on "Security" and adjustment on the Inventory, .45 in the case of boys, .43 and .48 for girls. Thus insecurity is mirrored in the self-reports for both boys and girls but seems to be in different context in boys and girls.

In conclusion, Abasement and Succorance, and with them "Insecurity" and "Introspection" seem to be the most decisive factors related to reactions on the Adjustment Inventory in the case of boys. Boys possessing these drives and traits describe themselves as maladjusted. The drive for Achievement and traits like "Personality Adjustment," "Security," "Self-sufficiency," "Seriousness of Efforts" are related to the reactions of the girls in their self-reports. Girls possessing these qualities describe themselves as adjusted. It is these features which the Adjustment Inventory is capable of measuring, at least to some extent.

In view of the discussion in this chapter, the suspicion of invalidity held against the Adjustment Inventory approach in recent years appears not entirely justified. The adjustment scores make definite sense when brought in relationship to certain data of the more dynamic or of the more comprehensive type, such as drives or general traits rated on the basis of prolonged and thorough acquaintance in a variety of situations. They do not make much sense if brought in relation to social behavior observed in specific situations. At least some of the drive categories, and along with them some related general traits, have shown significant relationships with an independent test such as the Adjustment Inventory, which in itself shows little relationship to social behavior. This may be taken as an indication of the fact that drive ratings are not merely artifacts originated by the raters, but that they hint at something real in the subjects. They possess some predictive value with respect to the reactions of the children and not merely with respect to the rating behavior of the judges. Further evidence on this point will be brought up in the next chapter.

X. RATED DRIVES COMPARED WITH FURTHER INDEPENDENT DATA

In this chapter independent data other than the Adjustment Inventory will be related to the drive ratings. Only scattered information is available thus far, however, on such relationships. It is planned to expand later, in a separate publication, on the topic sketchily dealt with in this chapter.

A. Rated Drives versus Projective Material

There is at present an increasing trend toward the use of "projective techniques" as an aid in diagnosing personality characteristics. This trend seems to be based chiefly on the hope that something of the personality, not readily apparent in ordinary manifest behavior, may be revealed in fantasy and related reactions. Quite in harmony with this assumption, studies of individual cases have frequently pointed to independent or even contradictory relations of manifest behavior and fantasy.

In cases in which, for example, a child is described as friendly and good-natured but full of aggressive fantasies, or as independent in behavior but longing for support in his fantasies, the present author would be inclined to assume that such apparent discrepancies occur only when the fantasy material is contrasted with indicators from overt behavior. When compared with drive ratings, inconsistencies should be less marked. In these interpretative ratings the friendly or independent child referred to above should, if our assumption is correct, appear as high on Aggression and Succorance independently of, but in accordance with, what is revealed in his fantasy.

One of the tests for the validity of such inferences (or intuitions) would consist in a direct comparison of the pattern of drives as inferred from behavior on the one hand, and as apparent in fantasy on the other. On a very limited scale such a test has been applied to our material.

Of our main group of 45 boys, 13 were selected who had been rated fairly unanimously by all three raters as high, medium, or low on the drive for Aggression. The reactions of these boys to the Murray *Thematic Apperception Test,* in a form modified by

H. E. Jones,[52] were then secured from records collected in the eleventh grade. Code numbers were assigned to each record, concealing the identity of the subjects. Four members of the Adolescence Study Staff—our three raters and one additional judge who did not know the children personally—were then asked to rate the intensity of the aggressive tendencies revealed in the stories told by the children. None of the raters had ever seen the protocols of this group before nor did they explicitly recognize the individuals by any secondary criteria. The limitation in the number of subjects was not primarily due to our desire to obtain subjects on whom the raters had previously agreed, but rather to the fact that a preliminary experiment with one of the raters had shown that only a limited quantity of unfamiliar material of this sort could be rated at one time and with the same standards.

For the same group of boys Abasement was also rated from their Murray picture records and compared with their average ratings on the drive for Abasement based on direct contact with the children. The drives for Aggression and Abasement were selected because of their basic importance as determinants of behavior and fantasy.

Table 19 shows drive ratings based on direct personal acquaintance and drive ratings based on reactions to the Murray pictures for both Aggression and Abasement, and for each of the judges. For Judge *G* two of the ratings were missing due to a misunderstanding. They could not be secured later since the identity of the children had meanwhile been disclosed. Averages in these cases are based on the remaining three judges. Question-marks indicate the uncertainty of the raters about their judgments. The degree of unanimity of the ratings on Aggression based on contact, which was the basis of the selection of our 13 subjects, can be seen directly from the first group of columns. There is also a surprising degree of agreement between the ratings of the four judges based on Murray picture stories.

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[52] The Murray Thematic Apperception Test consists of a set of pictures representing somewhat ambiguous and emotionally tinted situations. The subjects are asked to make up a story about each of these pictures. In the modification referred to here, some pictures of the Murray set were used, and others were added. The pictures were presented on a screen by means of lantern slides, the recorder sitting behind the subject and taking down a verbatim account of the story interpretation which he gave for each picture.

TABLE 19

RATINGS ON DRIVES BASED ON BEHAVIOR VS. RATINGS BASED ON RESPONSES TO MURRAY PICTURES (FANTASY RATINGS)

		Aggression							*Abasement*						
		Drive ratings based on direct contact			Drive ratings based on Murray picture stories				Drive ratings based on direct contact			Drive ratings based on Murray picture stories			
		Judges			Judges				Judges			Judges			
Case No.	Substitute No.	*F*	*G*	*H*	*F*	*G*	*H*	*M*	*F*	*G*	*H*	*F*	*G*	*H*	*M*
F- 6	1	2	3	3	4	4	4	2	2	3	2	1	2	2	2
B-14	2	4	3	3	2	5	2	3	2	2	3	4	2	2	5
A- 2	3	1	2	1	1	2	4	4	4	5	5	2	3	2	2
F-11	4	1	2	2	2	3	2	4	5	4	2	3	5	3	2
B-22	5	5	5	4	3	3	2	5	3	3	3	3	2?	2	1
A-10	6	2	1	1	3	1	1	1	2	1	1	1	1	1	1
B-16	7	3	3	3	2	1	1	1	4	3	2	3	3	2	2
E-13	8	5	5	5	5	5	4	5	3	4	5	2	4	2	2
B- 8	9	4	5	5	3	4	5	3	2	5	5	5	5	2	4
F- 9	10	5	5	5	4	3	4	4	2	4	3	3	3	3	4
F-20	11	1	2	1	1	1	1	2	1	2	4	2	1	2	2
E-31	12	2	4	2	3	—	3	2	1	1	2	1	3?	2	1
F-13	13	2	2	3	1	—	2	1	2	1	2	2	4?	3	2

In comparing the second group of columns with the first, it can be seen at a glance that the two approaches to the drive for Aggression and Abasement yield quite similar results. This has been followed up in a quantitative fashion by computing a rank order correlation between the averages of the three and four raters respectively on the two types of drive ratings for each subject. The rank order correlation for Aggression is .73, and the corresponding figure for Abasement is .54. We may not forget, however, that our sample of subjects is small and selected on the basis of little disagreement on their drive for Aggression. Nevertheless we have good reason to believe on the basis of these results that drive ratings of the kind used throughout this monograph can profitably be used on a larger scale than has been undertaken here in the investigation and analysis of fantasy material.

In order to test the stability of drive ratings based on stories, two raters rerated the subjects a few days later but before the identity of the children was disclosed. In seven cases out of eleven Judge *F* assigned the same ratings both times. For the remaining four the difference was only one point. Judge *M* assigned the same rating in four cases; there was a difference of one point in three cases and of more than one point in four cases. Judge *M*, who did not participate in our main rating procedure and the discussions preceding it, had difficulty deciding in four cases whether Aggression was a basic drive or a more surface defense reaction.[53]

As mentioned above, the general policy in this monograph is to treat motivation originating from reaction-formations on an equal footing with more basic types of motivation, if they have become well established.

B. THE RELATION OF DRIVES TO FLUCTUATION IN BEHAVIOR AND SELF-REPORTS

Some types of data from the Adolescence Study were collected at regular intervals of approximately half a year over the entire period of observation, eight years. As we have mentioned above, this was true for the self-reports (Adjustment Inventory). A similar procedure was followed for ratings on a number of behavior categories which were made when the children were waiting in groups of three to five, for the semi-annual physical examination conducted at the Institute of Child Welfare. These "Institute ratings" are even more specific than the social situation ratings referred to in the previous chapters.

An opportunity was thus given to compare our drive ratings not only with certain types of data, but also with fluctuations in time which might occur to a greater or lesser extent in some of these data. To be sure, some of these changes will be due to the lack of a certain kind of reliability, especially in the case of the Institute ratings. Though the inter-rater agreement on these Institute ratings is rather high (.8 or .9) as far as each single rating situation is concerned, there is a source of variability in the fact that the behavior of the child depended to a considerable extent upon the associates that he happened to be with at a given time. However, there remains the possibility that beyond such incidental changes, the fluctuations may provide essential additional information about the children.

There seem to be two primary ways in which changes with respect to any type of response can be conceived. First, one could be interested in consistent developmental trends. Second, one could be interested more in fluctuations proper. Considering the nature of our material, only the second alternative has been approached in this study. As a measure of the tendency of an individual to fluctuate, the average of the seven differences of the scores from year to year with respect to the variable in question was used.

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[53] This brings up the important point that defense mechanisms appear to be at work not only in actual behavior but also in projective material and even in dreams, and that they should be distinguished, at least for certain purposes, from more basic tendencies.

The program was carried out for a few items only, selected as the most promising. Out of the Institute rating scale the three items "initiative," "busy," and "confident" were used. Evaluation of the self-reports was limited to the category "direct ego damage." This is one of the sub-categories into which the items of the Adjustment Inventory were classified. It is expressed as a comprehensive score comprising the answers on items in which direct admission of one's shortcomings is involved (such as items involving nervousness, unhappiness, unpopularity, fearfulness, etc.). Examples of the way in which such questions are phrased were given in Chapter IX.

As a further limitation the fluctuation scores were derived for boys only. Correlation coefficients were then computed between the various kinds of fluctuation scores and the ratings received on the nine drive variables.

For fluctuations on the behavior ratings, correlations approaching significance were found for the items "initiative" and "busy." Fluctuation in "initiative" correlates around .4 with Aggression, Escape, and Succorance. This may be taken to mean that hostility, escape, and dependency tend to lead, in an alternating fashion, to bursts of initiative followed by inhibition.

Fluctuation with respect to the item "busy" correlates .44 with Recognition and .35 with Control and Achievement. This is quite in line with the above findings on "initiative." The emphasis is however shifted here to the prestige-seeking categories which seem at times to animate and at times to inhibit activities.

Fluctuation in "direct ego-damage" correlates .42 with Social Ties, .26 with Recognition, .30 with Aggression, .33 with Escape. Thus again boys high on our aggression cluster show some tendency to fluctuate between an optimistic opinion of themselves and the fear and admission that they are not as good as they aspire to be.

C. The Relation of Rated Drives to Family Data

So far nothing has been said in this monograph concerning the *origin of motivational tendencies.* The question has not yet been asked why one child is high on Aggression and full of ambition and another not. Although motivational tendencies are here thought of as relatively fundamental, or at least more fundamental than behavioral techniques, it is by no means implied that we should fall back on the theory of inborn instincts. On the contrary, we believe that persistent motivational tendencies have evolved as the result of environmental conditions, probably sometimes of a very subtle kind, and in early phases of childhood. Hostility and envy of a new sibling, an ambivalent or dominating mother, rivalry with an older brother, all these may well be of vital importance for the establishment of motivational patterns. Rivalry and ambition may persist though the older brother is now absent, or even forgotten. In short, what was a "press"—i.e., an environmental force—may be internalized and become a persistent motive. It seems important, therefore, to relate our material to whatever knowledge is available about the childhood of our subjects.

The California Adolescence Study, beginning observation of the children at approximately the age of 10, has comparatively little direct data on early childhood. In the data collection program, however, visits and interviews with the mothers of the children were included. On the basis of these interviews, the mothers were rated on a seven-point scale with respect to traits such as intelligence, attitude toward the study, some emotional qualities like "excitability," and on two items characterizing their attitude toward the child, i.e., "interest in the child" and "tendency to criticize the child."

Among the latter two items, one, "interest in the child," does *not* correlate with the children's motivations, possibly due to the ambiguity of this item. It may not sufficiently differentiate between rather disparate attitudes such as interest for the child's sake and interest for the mother's sake, over-protectiveness, a tendency to domineer, etc. However, the second item, "Tendency to criticize the child," shows significant correlations with the children's drives, namely, with Succorance:[54] .44 for boys and .35 for girls; with

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[54] Considering the probably low reliability of the home visit ratings, which

Recognition: .38 for boys and .34 for girls, and with Escape, .44 for girls. Mothers with a marked tendency to criticize the child may thus tend to foster a longing for support and/or a desire for prestige and for escape.

There also is some correlation between excitability of the mother and the drive for Social Ties in girls, .42, whereas the corresponding value in boys is .22. In boys the drive for Recognition shows a relation, though below significance, to the excitability of the mother, .33. Some relationships, though not significant, were found between self-assurance of the mothers and Aggression (.32), and Recognition (.30) in girls. Mother's "satisfaction with lot" shows a slight negative relationship with Abasement in girls (—.36). For the remaining data on the mothers either no correlations were computed or they were found insignificant. In the latter group are the items: "Cheerfulness" and "anxiety to make impression."[55]

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were made by one rater on the basis of one visit, and the not-too-high reliabilities of the drive ratings, the correlations obtained are quite substantial.

[55] An attempt was also made to relate the children's motivations to the social mobility of the parents. Not enough and not sufficiently precise data could, however, be secured on the tendency toward "social climbing" in the parents. But from the material available, we gained the impression that social mobility in the parents goes with aggressiveness in boys and with a striving for recognition in girls.

XI. CONCLUSION

Motivational ratings based on interpretation of behavior, applied to a group of about 100 subjects in the California Adolescent Growth Study, have proved to be of value in integrating and explaining personality data of various kinds. Though ultimately referred to observed behavior, reference to the underlying motivations was established as the result of a complex process of inference utilizing more subtle indirect cues together with gross features of behavior. The conclusions based upon the statistical analyses described in this study may be summarized as follows:

1. The drive ratings helped to organize the previously collected data on overt behavior observed in social situations. It was found that different classes of behavioral expressions were often related to one drive as alternative manifestations of that drive. Though many of the behavior items showed high intercorrelations when directly compared with one another, intercorrelations were low in many instances, resulting in two relatively independent clusters, named "overt social activity" and "emotional maladjustment." Items in both of these categories, however, show close relationships to some of our rated drive categories such as the drives for Social Ties, Recognition, Aggression, Control, and Escape. A synopsis of these results as well as an analysis in terms of multiple correlations suggests that the two unrelated groups of manifestations mentioned above are but alternative manifestations of one and the same set of dynamic factors. Thus, for adolescents whose ratings on the aggressive drive cluster listed above are high, there is a likelihood that they will be either emotionally maladjusted, or successful in their overt social activity, or they may even display both manifestations (Chapters VI and VII).

Similar "and/or" patterns have also been found when ratings of more generalized manifest traits, emphasizing especially consistent attitudes, habits, and actual adjustment, were correlated with the rated drives. In addition to the drive variables listed above, the rated drives for Abasement, Succorance, and Achievement likewise showed relationships with a number of such general behavior traits (Chapter VIII). For example, girls high on Abasement are high on either "Altruism" or "Insecurity" or both. The alternates *for boys high on Abasement are, among others,* "Strength of Superego" and/or "Insecurity."

Analogously, but in the opposite *direction, certain manifest features*, especially those concerned with adjustment, seem to originate in a variety of underlying motivational conditions. For example, a higher order multiple correlation of .8 was found between security on the one hand and the drives for Abasement, Aggression, Succorance, and lack of Achievement on the other hand. Thus, adjustment and security and also maturity seem to stem from alternate dynamic origins. The latter are independent of each other and therefore contribute significantly to the total correlation.

The network of correlations discussed shows that the relations between motivational patterns and overt behavior are ambiguous in *both directions. One drive variable circumscribes a family of* alternative manifestations unrelated to each other. The meaning of the drive concept emerges in terms of families of divergent manifestations held together dynamically or genotypically, though often not phenotypically. And, on the other hand, one overt expression may be related to several underlying tendencies. However the "indeterminacy" of the relationships between drives and behavior is somewhat reduced if total drive patterns are related to behavior patterns (Chapter VII, Section D).

The complex statistical relationships between drives and behavior, described above, can be taken as operational specifications of the meanings of the drives. By our correlational analysis we were able to determine what the raters actually did in rating the subjects, i.e., *which behavioral cues they used for inferring the drives. We did* not have to rely on explicit statements of what they thought they did, or what they thought were the relationships between drive and manifestation. In no case does this study thus get involved in the fallacies of an introspective analysis or rationalization of the relationship between drive and manifestation on the part of the raters.

2. Drive ratings show good relationships to independent data such as self-reports (Adjustment Inventory), showing that they can predict the behavior of the subjects in situations which did not enter as a basis for the drive inferences. Drive ratings are thus instrumental in bridging the gap existing between overt behavior and other types of reactions such as self-report questionnaires (Adjust-

ment *Inventory*) and "*projective material*." Self-reports do not mirror behavior directly but they show relationships to some of the underlying drives, and thus indirectly to behavior related to these drives. Not only do the drive variables help in selecting the items which, often contrary to expectation, show relationships between one set of data and another, but they also help us to explain the absence of relationships where positive correlations had been expected. Thus, for example, the low correlations found for boys between maladjustment in actual behavior and in the self-reports can be accounted for by the fact that maladjustment may stem either from the aggressive cluster of drives or from Abasement or Succorance, but it is admitted in the self-reports only in the latter of the two alternatives (Chapter IX).

Furthermore, tentative analyses point in the direction of good agreement between drive ratings as based on the interpretation of behavior and ratings derived from fantasy material (thematic apperception test), whereas general clinical experience indicates a frequent discrepancy between overt behavior and fantasy. This lack of consistency may possibly be understood by reference to underlying motivation (Chapter X).

3. A third point upon which light is thrown by our data is the problem of the justification of the concept of motivation in general, and the status of the drive ratings employed here in particular. We have seen that drive ratings correlate not only with behavior upon which they are partly based, but also with material from independent sources, and that these correlations are higher than those between manifest behavior and the independent data; this may be regarded as evidence that drive ratings genuinely indicate dynamic states within the subjects rated, rather than mere reflections, explicit or implicit, of notions existing only in the heads of the raters.

The subjective component that is nevertheless present in the ratings to some extent, has been discussed in Chapters III and IV. An attempt was made to analyze explicitly and objectively (*a*) the conceptions of drive categories, varying within certain limits from rater to rater; the influence of (*b*) the raters' emotional attitudes toward the children and (*c*) their own drive-patterns, upon the ratings. These subjective factors, though present, tend to cancel themselves out in their unsystematic variation. Hence there remains predictive value in the averaged ratings.

The concept of drives supplies us with an instrument which, due to its particular level of abstraction, is helpful in uncovering relationships and consistencies in the field of personality, provided that the relation between inferred drives and behavior have been quantatively analyzed, and their operational meanings have thus been specified.

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